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★ **WILD ANIMAL ATTACKS**
— IN YOUR OWN BACKYARD p. 76

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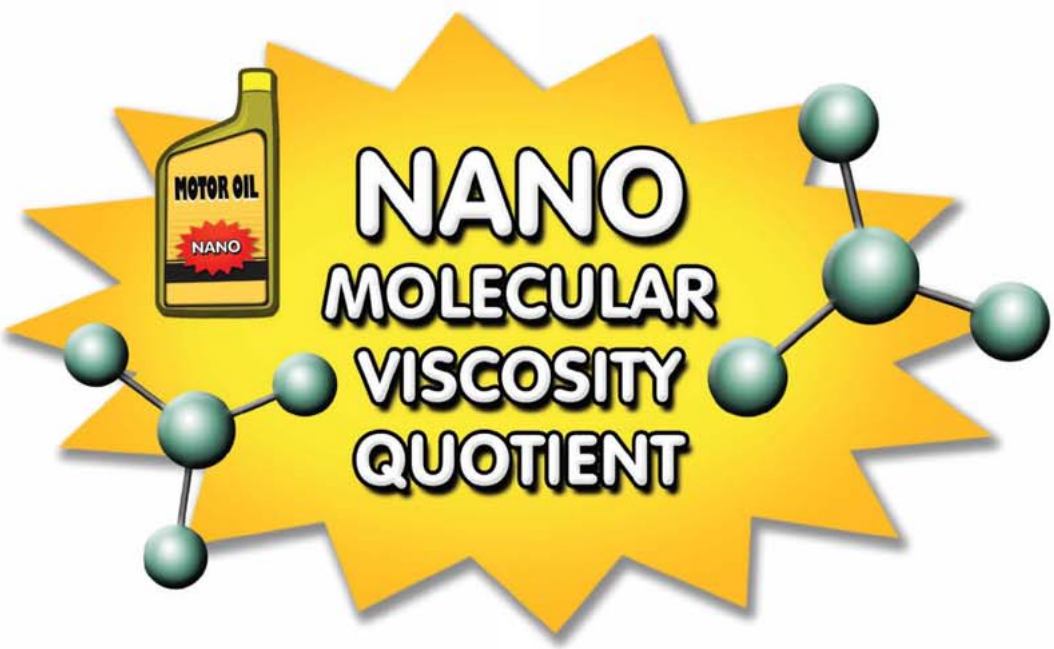
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PM FEATURES /// JULY 2009
VOLUME 186 NO. 7



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25 BIG IDEAS

The world has challenges; we have solutions. Presenting the PM action plan, from real-world fusion to better airplanes to traffic-busting cars.
BY ERIK SOFGE

← Geologist Peter Kelemen holds a chunk of peridotite, a rock that could hold the key to carbon sequestration.

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BY NOAH SHACHTMAN

ON THE COVER **Blended-wing aircraft being developed for the military could give rise to planes like this commercial airliner, sharply reducing fuel consumption and noise. Rendered by Jeremy Cook.**

ICONS BY DOGO (COVER)

PHOTOGRAPH BY **MIKE MCGREGOR**

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WHAT THEY'RE DOING



AMY B. SMITH

MIT instructor, 2008 Breakthrough Leadership Award winner
Smith spent much of the 2009 spring semester working in Ghana, Zambia and Haiti, disseminating appropriate technology construction strategies and working to bolster local economies. This month, the inventor hosts the third International Development Design Summit in Ghana, bringing together people from around the world to brainstorm new technologies for developing countries.

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Bigger Toolbox?

Your story "50 Tools We Can't Live Without" highlighted a great selection of tools. I'm only missing the ohmmeter (I wouldn't know what to do with it). But I would have liked a few more. The handsaws could have been replaced with the more accurate Japanese pull or cabinet saws. Most importantly, you omitted the remodeler's best friend—the reciprocating saw. It is perhaps the most versatile tool I own, except for a pencil. Oh, yes—you forgot the pencil, too.

JIM STACEY
FAYETTEVILLE, NC

I very much enjoyed your tools article but believe that some of them are misplaced. Outdoor lawn and garden tools are important but not always needed, depending on where you live. I also think that a good set of form-fitting mechanic's gloves is a must in any toolbox.

STEVEN MENZIK
IOWA PARK, TX

ISSUE
05/09

Readers responded to our list of 50 tools every man needs and a missionary's flying vehicle.

I find myself in slight disagreement with a few of your must-have tools. Do you seriously consider WD-40 and a dust mask tools? They are supplies, in line with shop towels and Lava soap. If I were selecting just 50, I would have included some C-clamps, a wire brush, propane torch and ax. Great article otherwise, thanks.

TONY JUSTIN
LEE'S SUMMIT, MO

Your story on 50 tools was a beaut. I'll bet that I'm only one of hundreds of readers who wrote to say there was one thing missing—duct tape, the most indispensable tool of all.

DONALD PACK BRYAN
PITTSBURGH, PA

Mission Accomplished

Logan Ward's "The Mission," about inventor and Amazonian missionary Steve Saint and his flying dune buggy, was one of the best articles I have read in your magazine over many years. What's not to like about an airplane that doesn't need a pilot or a runway? (I want one myself for commuting.) Yes, it was popular and mechanical, but the story was enriched by the details of Saint's family and his personal history.

MARK PICHAJ
BURBANK, CA

I was pleased that your article on Steve Saint and his invention included his family history, which showed the desire of missionaries to help tribes in the Amazon. It really added background on Steve's interest, commitment and motivation to create his flying vehicle. I hope to see a followup article describing how the canopy is stored when driving in the jungle.

TIM CALEY
WEYMOUTH, MA

what do you think?

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popularmechanics.com/rebuildingamerica



HOME COOLING 101

Air conditioners are one of the biggest energy—and money—drains in the home. The PM editors have all the tips you need to stay cool, without cranking up that old a/c. ***popularmechanics.com/home_journal***



SUMMER MYTHS

Will turning on the heat really cool down an engine? Does the summer require thicker oil? What kind of coolant? Mike Allen debunks summer auto myths and gives tips to keep cars fit year-round. ***popularmechanics.com/auto***

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Photograph By Doris Thibeault



Men with Erectile Dysfunction (ED) are discovering that VIAGRA can help them get and keep harder erections, which can lead to more satisfying sexual experiences. ***Get the message yourself at viagra.com.*** Then ask your doctor if VIAGRA is right for you.

Viva VIAGRA® *(sildenafil citrate) tablets*

VIAGRA is prescribed to treat erectile dysfunction. We know that no medicine is for everyone. Don't take VIAGRA if you take nitrates, often prescribed for chest pain, as this may cause a sudden unsafe drop in blood pressure.

Talk with your doctor first. Make sure your heart is healthy enough to have sex. If you have chest pain, nausea, or other discomforts during sex, seek medical help right away. As with any ED tablet, in the rare event of an erection lasting more than four hours, seek immediate medical help to avoid long-term injury.

In rare instances, men taking PDE5 inhibitors (oral erectile dysfunction medicines, including VIAGRA) reported a sudden decrease or loss of vision, or sudden decrease or loss of hearing. It is not possible to determine whether these events are related directly to these medicines or to other factors. If you experience any of these symptoms, stop taking PDE5 inhibitors, including VIAGRA, and call a doctor right away.

The most common side effects of VIAGRA are headache, facial flushing, and upset stomach. Less common are bluish or blurred vision, or being sensitive to light. These may occur for a brief time.

Take VIAGRA about 1 hour before you want to have sex. VIAGRA works for 4 hours. VIAGRA only works with stimulation. VIAGRA does not protect against sexually transmitted diseases including HIV. Please see Important Facts for VIAGRA on the following page or visit viagra.com for full prescribing information. **For free information, including questions to ask your doctor, call 1-888-4VIAGRA (1-888-484-2472).**

***Data taken from a study of 228 men with ED who previously had success with VIAGRA. Of the 115 men who took VIAGRA 100mg, 35% had erections hard enough for successful intercourse at 14 minutes, and 51% of men at 20 minutes.**

Individual results may vary.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.FDA.gov/medwatch or call 1-800-FDA-1088.

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Pfizer

IMPORTANT FACTS

VIAGRA® *(sildenafil citrate) tablets* (vi-AG-rah)

IMPORTANT SAFETY INFORMATION ABOUT VIAGRA

Never take VIAGRA if you take any medicines with nitrates. This includes nitroglycerin. Your blood pressure could drop quickly. It could fall to an unsafe or life-threatening level.

ABOUT ERECTILE DYSFUNCTION (ED)

Erectile dysfunction means a man cannot get or keep an erection. Health problems, injury, or side effects of drugs may cause ED. The cause may not be known.

ABOUT VIAGRA

VIAGRA is used to treat ED in men. When you want to have sex, VIAGRA can help you get and keep an erection when you are sexually excited. You cannot get an erection just by taking the pill. Only your doctor can prescribe VIAGRA.

VIAGRA does not cure ED.

VIAGRA does not protect you or your partner from STDs (sexually transmitted diseases) or HIV. You will need to use a condom.

VIAGRA is not a hormone or an aphrodisiac.

WHO IS VIAGRA FOR?

Who should take VIAGRA?

Men who have ED and whose heart is healthy enough for sex.

Who should NOT take VIAGRA?

- If you ever take medicines with nitrates:
  - Medicines that treat chest pain (angina), such as nitroglycerin or isosorbide mononitrate or dinitrate
- If you use some street drugs, such as "poppers" (amyl nitrate or nitrite)
- If you are allergic to anything in the VIAGRA tablet.

BEFORE YOU START VIAGRA

Tell your doctor if you have or ever had:

- Heart attack, abnormal heartbeats, or stroke
- Heart problems, such as heart failure, chest pain, or aortic valve narrowing
- Low or high blood pressure
- Severe vision loss
- An eye condition called retinitis pigmentosa
- Kidney or liver problems
- Blood problems, such as sickle cell anemia or leukemia
- A deformed penis, Peyronie's disease, or an erection that lasted more than 4 hours
- Stomach ulcers or any kind of bleeding problems

Tell your doctor about all your medicines. Include over-the-counter medicines, vitamins, and herbal products. Tell your doctor if you take or use:

- Medicines called alpha-blockers to treat high blood pressure or prostate problems. Your blood pressure could suddenly get too low. You could get dizzy or faint. Your doctor may start you on a lower dose of VIAGRA.
- Medicines called protease inhibitors for HIV. Your doctor may prescribe a 25 mg dose. Your doctor may limit VIAGRA to 25 mg in a 48-hour period.
- Other methods to cause erections. These include pills, injections, implants, or pumps.

POSSIBLE SIDE EFFECTS OF VIAGRA

Side effects are mostly mild to moderate. They usually go away after a few hours. Some of these are more likely to happen with higher doses.

The most common side effects are:

- Headache
- Feeling flushed
- Upset stomach

Less common side effects are:

- Trouble telling blue and green apart or seeing a blue tinge on things
- Eyes being more sensitive to light
- Blurred vision

Rarely, a small number of men taking VIAGRA have reported these serious events:

- Having an erection that lasts more than 4 hours. If the erection is not treated right away, long-term loss of potency could occur.
- Sudden decrease or loss of sight in one or both eyes. We do not know if these events are caused by VIAGRA and medicines like it or caused by other factors. They may be caused by conditions like high blood pressure or diabetes. If you have sudden vision changes, stop using VIAGRA and all medicines like it. Call your doctor right away.
- Sudden decrease or loss of hearing. We do not know if these events are caused by VIAGRA and medicines like it or caused by other factors. If you have sudden hearing changes, stop using VIAGRA and all medicines like it. Call your doctor right away.
- Heart attack, stroke, irregular heartbeats, and death. We do not know whether these events are caused by VIAGRA or caused by other factors. Most of these happened in men who already had heart problems.

If you have any of these problems, stop VIAGRA. Call your doctor right away.

HOW TO TAKE VIAGRA

Do:

- Take VIAGRA only the way your doctor tells you. VIAGRA comes in 25 mg, 50 mg, and 100 mg tablets. Your doctor will tell you how much to take.
- If you are over 65 or have serious liver or kidney problems, your doctor may start you at the lowest dose (25 mg).
- Take VIAGRA about 1 hour before you want to have sex. VIAGRA starts to work in about 30 minutes when you are sexually excited. VIAGRA lasts up to 4 hours.

Don't:

- Do not take VIAGRA more than once a day.
- Do not take more VIAGRA than your doctor tells you. If you think you need more VIAGRA, talk with your doctor.
- Do not start or stop any other medicines before checking with your doctor.

NEED MORE INFORMATION?

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We did find a magnificent cache of cultured pearls at the best price that I have ever seen. Our pearl dealer was stuck. A large luxury department store in financial trouble cancelled a large order at the last minute so we grabbed all of them. He sold us an enormous cache of his roundest, whitest, most iridescent cultured 5 ½–6mm pearls for only pennies on the dollar.

But let me get to the point: his loss is your gain. Many of you may be wondering about your next gift for someone special. In the past, Stauer has made gift giving easier with the absolute lowest prices on fine jewelry and luxury goods. This year, we've really come to the rescue.

For the next few days, I'm not offering this cultured pearl necklace at $1,200. I'm not selling it for $300. That's because I don't want to SELL you these pearls at all... I want to *GIVE* them to you. This cultured pearl necklace is yours **FREE**. You pay nothing except basic shipping and processing costs of $25.95, the normal shipping fee for a $200–$300 necklace.

It's okay to be skeptical. But the truth is that Stauer doesn't make money by selling one piece of jewelry to you on a single occasion. We stay in business by serving our long term clients. And as soon as you get a closer look at the exclusive selection, you're not going to want to buy your jewelry anywhere else.

Stauer is a high end jeweler that still understands value. As a matter of fact, our average client spends more with us than at Tiffany's, but we still know something about affordability. We believe Stauer was the largest buyer of carat weight emeralds in the world last year and this year we are on track to be the largest buyer of carat weight sapphires, so we know about volume buying discounts. We were only able to get so many pearls at this price. This offer is ***very limited*** to one per shipping address. Please don't wait.



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Tech Watch



How to Land on Mars

TO SURVIVE ITS FALL, THE MASSIVE NEW MARS ROVER WILL DEPEND ON THE LARGEST SPACE PARACHUTE EVER BUILT.

BY MORGAN LORD

When the NASA Mars Science Laboratory rover lands on Mars in 2012, it will face a unique obstacle: With an Earth weight of nearly a ton (compared to about 400 pounds for previous Mars rovers) and a Mars weight of about 750 pounds, it is too massive for any existing space parachute. So to cushion its fall through the thin Martian atmosphere (which is less than 1 percent as dense as Earth's), NASA engineers had to come up with something really big. The new parachute opens to a diameter of 52 feet, making it twice the size of any parachute ever flown beyond Earth.

To test the parachute, which was built by Pioneer Aerospace, NASA brought it into the world's largest wind tunnel, located at NASA Ames Research Center in Moffett Field, Calif. The parachute passed flight-qualification testing in April, and is now ready for the rover's 2011 launch date.

New Flying Car—at Dealers Soon?

There have been many attempts at producing a flying car over the years—maybe too many. None has found its way onto consumer driveways. But a vehicle billed as the world's first practical flying car had its Kitty Hawk moment on March 5, when it successfully maintained flight for 37 seconds. The two-seat Transition, classed by the FAA as a Light Sport Aircraft, is a proof-of-concept built by Terrafugia, an MIT spinoff. Using ordinary unleaded gasoline, it can fly at 115 mph with a range of 460 miles, morph into a road-safe car in less than 30 seconds, pull 30 mpg on the highway and fit into an ordinary garage. The company is taking deposits and plans to deliver vehicles in 2011 for about $200,000.



NEWSBRIEFS

Reports From the Edge of Science

Compiled by Alex Hutchinson

VIRUS-BUILT BATTERIES

+ In 2006, MIT researchers made strides toward completing a virus-built lithium-ion battery. Now, the scientists have solved a missing piece of the puzzle by engineering a virus that can create cathodes by sheathing itself in iron phosphate before attaching to carbon nanotubes. The new battery is currently in the prototype stage; the process could yield cheaper batteries that are less toxic to produce than today's lithium-ion cells.



Battery-Powered Sub

+ An unmanned autonomous submarine successfully mapped out 300 miles of seafloor underneath the thick ice of Antarctica's Pine Island Glacier. The sub's creative source of power: 5000 off-the-shelf D batteries. The "Autosub," which was built at Britain's National Oceanography Centre, is equipped with multibeam sonar that allows it to create detailed maps while navigating between jagged ice above and an unmapped seafloor below.

Rise of the Robot Scientists

+ Could robots soon make scientists obsolete? Two groups of researchers have announced advances in the quest to create a computer capable of developing experiments, testing hypotheses and learning from the results. Researchers at Aberystwyth University and the University of Cambridge in the U.K. have built a robot biologist that can design and conduct experiments to identify genes involved in yeast metabolism. Meanwhile, researchers at Cornell University have created a machine able to deduce natural laws by observing physical systems.

BRIDGE MONITORING



+ At the end of 2008, more than one out of every four bridges in the United States was classified as either structurally deficient or obsolete by the Department of Transportation. To help fix this, researchers at Florida's University of Miami are testing wireless sensors that transmit real-time data about vibrations and deformations affecting a structure. The sensors gather data by listening for echoes from cracks, and by measuring alkaline levels to monitor corrosion. Sensor power will be harvested from wind and structural vibrations.

SPACE RADIATION

+ After two years of data analysis, a team of international researchers has discovered the cause of a mysterious source of space radiation called the far infrared background. The radiation, which was discovered a decade ago by NASA's COBE mission, comes from a group of galaxies located 7 billion to 10 billion light years away. As hot new stars are formed in these galaxies, light from them is absorbed by nearby dust, which heats up and re-emits the infrared signal astronomers had been puzzling over.

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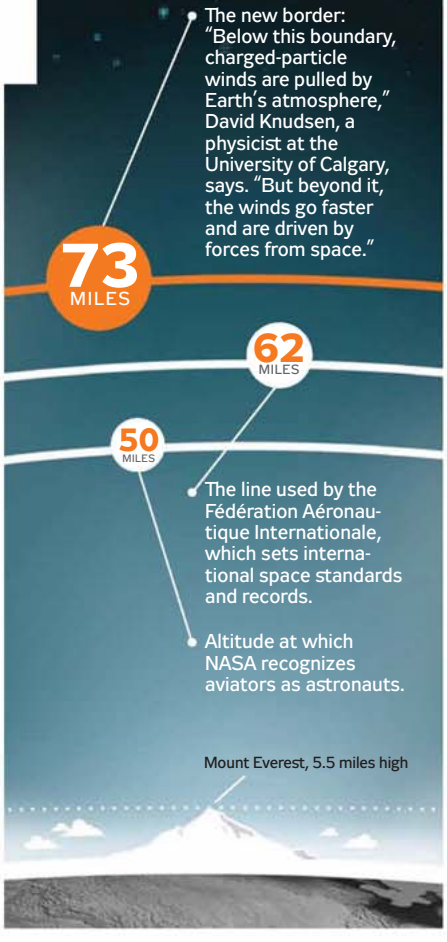
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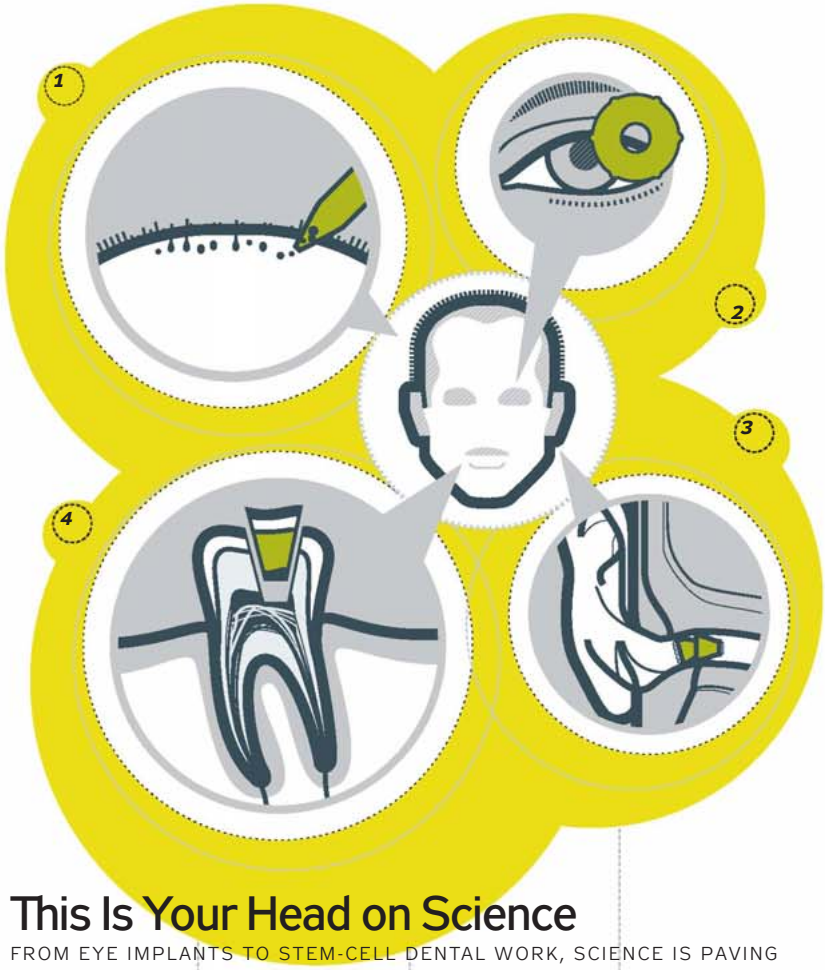
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Space's Final Frontier?

Where does the Earth's atmosphere end and space begin? That depends whom you ask. Various definitions have fought it out. In 1961, Alan Shepard reached an altitude of 116 miles to become the first American in space; *SpaceShipOne* nabbed the Ansari X Prize in 2004 after hitting 62 miles. But scientists at Canada's University of Calgary say new technology has allowed them to pinpoint the border: It lies 73 miles above the Earth's surface. That's where relatively gentle atmospheric winds begin to give way to space's maelstrom-like particle flows, which can exceed 600 mph. The data comes from the Supra-Thermal Ion Imager, which was sent into space in 2007. — *SETH PORGES*





This Is Your Head on Science

FROM EYE IMPLANTS TO STEM-CELL DENTAL WORK, SCIENCE IS PAVING THE WAY FOR NEXT-GEN MEDICAL PROCEDURES. *BY AMBER ANGELLE*

Whether the goal is sharper hearing or sharper looks, researchers continue their efforts to improve the features nature gave us. These head-centered therapies employ everything from stem cells to tiny electronics in their pursuit of aesthetic advantage. They could lead to wide-ranging medical advances—or just more lucre for cosmetic surgeons.

1 Next-Gen Hair Transplant

+ Scientists at Atlanta-based Aderans Research Institute are researching a way to create a nearly inexhaustible supply of hair plugs. Instead of merely transplanting hair cells from a patient's tissue, researchers extract the cells and grow them in a lab, multiplying them about a hundredfold before injecting them into the scalp.

Availability: *Projected within five years.*

2 Color-Changing Eye Implant

+ Color-changing contacts have been around for years, but they are easy to spot. NewColorIris lenses, developed by Panama-based KMD, are surgically implanted on the iris (the procedure takes 15 minutes), with a donutlike hole for the pupil to peep through. The result: a permanent, more natural-looking pair of baby blues.

Availability: *In Panama and Switzerland now. FDA trials will begin soon.*

3 Invisible Hearing Aid

+ Most hearing aids are bulky and unsightly. California-based InSound Medical has created perhaps the most discreet hearing aid yet. The Lyric rests deep in the ear canal, out of sight, and out of the way of wind. A wireless keychain remote controls volume, and the device can be left in the ear for up to four months at a time.

Availability: *Available since January 2009.*

4 Natural Tooth Filling

+ Researchers at Tufts University are working on a way to use stem cells to repair tooth decay. How it works: Tooth-growing cells are seeded into polymer scaffolds. The scaffolds are then implanted into the jaw, where they regenerate tooth enamel, dentin and pulp. The operation has been successfully tested in pigs and rats.

Availability: *Could be available for humans within seven years.*

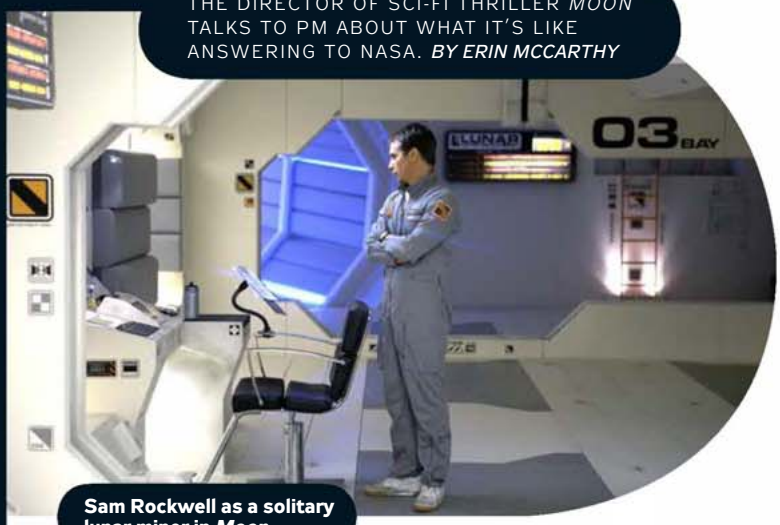
ILLUSTRATIONS BY BRADLEY R. HUGHES (SPACE); DOGO (HEAD)



TECH CULTURE

Duncan Jones

THE DIRECTOR OF SCI-FI THRILLER *MOON* TALKS TO PM ABOUT WHAT IT'S LIKE ANSWERING TO NASA. ***BY ERIN MCCARTHY***



Sam Rockwell as a solitary lunar miner in *Moon*.

If you met yourself in person, would you like you? It's a question director Duncan Jones asked when conceptualizing *Moon,* out June 12. The film—which follows a solitary lunar miner named Sam (Sam Rockwell)—is a throwback to sci-fi classics such as *Blade Runner,* where the central conflict involves questions of identity and the moral compromises caused by advancing technology.

Q Sam Rockwell's character manages a moon base where helium-3 is mined for use in fusion reactors on Earth. Harrison H. Schmitt, the only geologist to go to the moon, wrote a story about the same thing for PM's October 2004 issue, but where did you get the idea?

A I didn't know PM had done an article on that. I had read Robert Zubrin's book *Entering Space: Creating a Spacefaring Civilization,* about how we could financially justify colonizing the solar system. There was a chapter on colonizing the moon and using helium-3 for fusion power.

Q You recently did a screening of *Moon* for NASA employees. What was the reception like?

A It was fantastic. [PM editorial advisory board member and former astronaut] Tom Jones said that one of the things I got right was the mundaneness of working in that environment. You do a lot of really boring stuff again and again.

Q Why did you choose to put the base on the dark side of the moon when there's more helium-3 on the near side?

A That came up at NASA. My reason is that when you start harvesting helium-3, you're scooping up the first few inches of lunar regolith and bringing it into the harvesting machine, cooking it to release the gas, and then kicking the debris out the back. Because it's going through the cooking process, there will be chemical changes. That's going to affect, possibly, the reflectivity of what's kicked out—literally changing the reflectivity of the moon. What's that going to do to wildlife or things back on Earth? Do you want to take [that] risk on the near side?

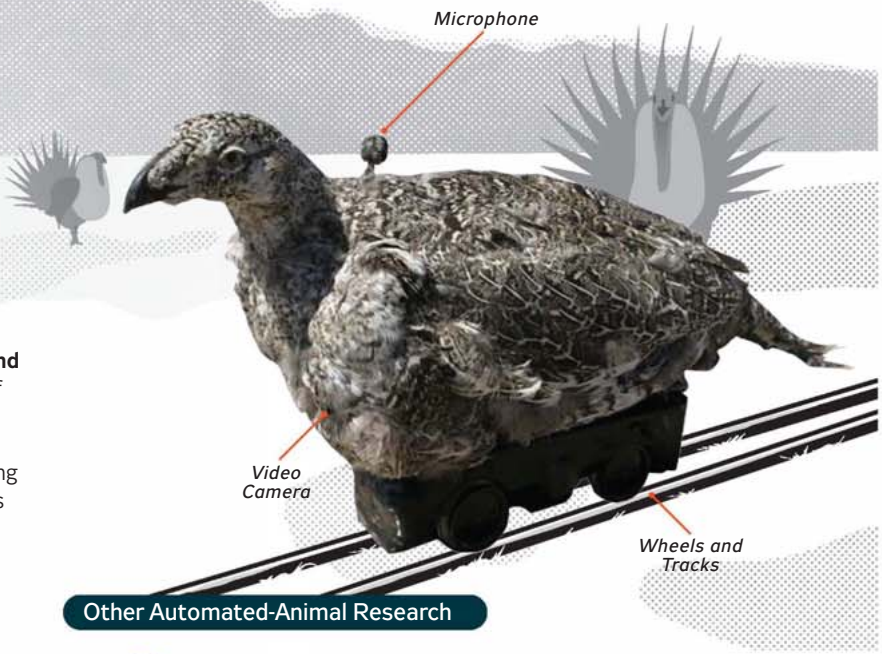
PHOTOGRAPH BY GETTY IMAGES (DUNCAN JONES)



The Origin of Robot Species

SCIENTISTS DISGUISE ROBOTS IN CREATURE CLOTHING TO GET AN INTERACTIVE VIEW OF ANIMAL BEHAVIOR—AND ROMANCE.

BY ERIN MCCARTHY



Mating on the breeding ground begins at dawn, so University of California–Davis assistant professor Gail Patricelli has to have her female sage-grouse robot out of the concealing blind and ready to be wooed by suitors before the sun is up. Scientists like Patricelli are using animal doppelgängers to decode creature behavior and communication based on how real beasts respond to a robot's mannerisms. Patricelli, who is studying sexual selection, outfitted her bird bot with a video camera and microphone to capture males' auditory and visual cues. "I can use the robot to mimic a particular female signal or behavior and then see whether males that are more responsive are also more successful in courtship," Patricelli says. Sure, the robot has wheels instead of legs, but that doesn't bother the males—they routinely mate with cow pies.

Other Automated-Animal Research



+ **BEES** In the early 1990s, Axel Michelson at the University of Southern Denmark built a robotic honeybee to test the hypothesis that real bees communicate directions to flowers using a dance. He was able to confirm the idea, despite using a robot that didn't look like a bee—it was larger and had one wing. The experiment took place within the darkened environment of a hive, so the oddball appearance didn't alienate other bees.

+ **SQUIRRELS** Sarah Partan, an assistant professor at Hampshire College, built a robotic Eastern gray squirrel that uses visual and audio signals to better understand communication between real squirrels. At UC Davis, graduate student Aaron Rundus used a robotic California ground squirrel to study a tail-flagging display that squirrels use to intimidate rattle and gopher snakes.

+ **LIZARDS** Indiana University professor Emília Martins is using a robot to study how lizards react to displays of courtship and aggression. Both in the lab and in the wild, real lizards responded to the faux lizard's push-up displays and head bobs.



The RubbleViewer software combines photographs of a disaster site into a navigable 3D map.

A New Way to Map Disasters

When disaster strikes, every minute matters. And the time spent surveying the scene is time that can't be spent saving survivors.

Researchers at Texas A&M University and Delft University of Technology in the Netherlands have collaborated on a way to speed up the process. Small robots take photos of the disaster site. The photos are then uploaded to a computer program called RubbleViewer that transforms them into a three-dimensional map of the site. (The program is based on Microsoft's Photosynth software, which won a 2008 PM Breakthrough Award.)

This could speed up rescues. "It can take 10 hours to extract somebody because you don't know the structure," says Robin Murphy, a professor of computer science and engineering at Texas A&M. "This will give structural engineers more accurate information to speed up extraction."

RubbleViewer's creators hope to get the software to first responders by August, when hurricane season normally hits its peak. —*S.P.*

ILLUSTRATIONS BY BRADLEY R. HUGHES



Recharge your T levels. What you do next is up to you.

Low energy. Moodiness. Low sex drive.

These may not be just normal signs of aging. They are a few of the symptoms experienced by many of the 13.8 million men aged 45 years or older with a common medical condition called low testosterone (Low T). On the bright side, Low T is easily treatable. AndroGel restores your T levels to normal range and may improve your symptoms over time.

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AndroGel is indicated for replacement therapy in adult males for conditions associated with a deficiency or absence of endogenous testosterone.

SAFETY INFORMATION:

AndroGel must not be used if you have known or suspected prostate cancer or breast cancer (a rare condition for men). AndroGel must not be used by women who are pregnant, may become pregnant, or breastfeeding, as testosterone may cause fetal harm.

The major risks of AndroGel include prostate enlargement, prostate cancer, and transfer of testosterone to others (including women and children). Transference can occur when vigorous skin-to-skin contact is made with the application site and can be minimized by washing your hands after application and covering the application site with clothing.

The most common adverse events reported are skin irritation where gel is applied, breast development or tenderness, acne, prostate enlargement, changes in lab test results, and changes in urinary habits.

Remember, the information in this ad does not take the place of the advice you get from your doctor or other health care professional. Always talk with your doctor if you have questions about AndroGel.

Please see brief summary of Patient Information on next page.

You are encouraged to report side effects of prescription drugs to the FDA. Visit www.FDA.gov/medwatch or call 1-800-FDA-1088.

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AndroGel®
(testosterone gel) 1% CIII

℞ only

Brief Summary of Patient Information (For full Prescribing Information and Patient Information, refer to package insert.)

The following information about AndroGel® should not take the place of your doctor's orders or recommendations. Your doctor will tell you exactly what dose to take, how to safely take it, and when to take it. Make sure you understand the benefits and risks of AndroGel® before you use it. If you have any other questions about AndroGel® therapy, ask your doctor or pharmacist or visit www.androgel.com.

AndroGel (testosterone gel) 1% CIII is available packaged with 2 x 75 g pumps (each pump dispenses 60 metered 1.25 g doses) or in a box of 30 packets with 2.5 g or 5 g gel.

This is a summary of the important information about AndroGel. For details, talk to your healthcare professional and refer to the package insert.

1. What Disease or Condition Does AndroGel Treat?

Your healthcare provider has prescribed this medication because your body does not produce enough testosterone. The medical term for this condition is hypogonadism.

2. How Should AndroGel (Pump or Packet) Be Applied?

It is important that you use AndroGel as prescribed by your healthcare professional. If you experience serious problems, contact your healthcare professional. Your healthcare professional will tell you how much AndroGel to use each day.

Men should apply gel to shaded areas (upper arm/shoulders, and/or abdomen) only.



Site(s) of Gel Application

- **AndroGel should be applied once daily at the same time each day** (preferably every morning) to clean, dry, healthy, intact skin of the shoulders, upper arms and/or abdomen. If you take a bath or shower in the morning, use AndroGel **after** your bath or shower.
- AndroGel **should not** be applied to the **penis or scrotum,** or to skin with open sores, wounds or irritation.
- **Wash your hands** with soap and water immediately **after application** to reduce the chance that the medication will spread from your hands to other people.
- Let AndroGel dry for a few minutes before you dress.
- **AndroGel is flammable until dry**; allow the gel to dry before smoking or going near an open flame.
- **Wait 5 to 6 hours** before showering or swimming. This will ensure that the greatest amount of AndroGel is absorbed into your system.

How to use the AndroGel pump?

It is important that you read and follow these directions on how to use the AndroGel Pump properly. Before using the pump for the first time, you must prime the AndroGel pump by fully depressing the pump three times and discarding the gel. The unused gel should be discarded in a manner to avoid accidental exposure or ingestion by household members or pets. Fully depress the pump the appropriate number of times to deliver the daily dose prescribed by your healthcare provider. The product may be delivered directly into the palm of your hand and then applied to the desired application sites, either one pump depression at a time or upon completion of all pump depressions required for the daily dose.

How to use the AndroGel packets?

Open one AndroGel aluminum foil packet by folding the top edge at the perforation and tearing completely across the packet along the perforation. Squeeze the contents into the palm of your hand. Squeeze from the bottom of the packet toward the top. If you like, you may squeeze a portion of the gel from the packet into the palm of your hand and apply to application site(s). Repeat until the entire contents of the packet have been applied.

3. What Should You Discuss With Your Healthcare Professional?

Before you start using AndroGel, tell your healthcare professional if you:

- Have prostate cancer or breast cancer.
- Have a known hypersensitivity to any of AndroGel's components, including individuals who are hypersensitive to testosterone that is chemically synthesized from soy.

4. What Other Drugs Should Not Be Used Together With AndroGel?

Tell your healthcare provider about all of the medicines you take, including prescription and non-prescription medicines, vitamins and herbal supplements. AndroGel can affect how your body handles other drugs. Changes in your dose or careful monitoring may be needed if you are taking any of the following medications:

- Insulin
- Corticosteroids
- Oral Anticoagulants

5. What Are The Side Effects And Risks?

Possible side effects of AndroGel to discuss with your healthcare professional include:

Most common: Skin irritation where gel is applied, breast development or tenderness, acne, prostate enlargement, changes in lab test results and changes in urinary habits.

Contact your healthcare professional if you experience any of the following adverse reactions:

- Too frequent or persistent erections of the penis.
- Any nausea, vomiting, changes in skin color or ankle swelling.
- Breathing disturbances, including those associated with sleep, or excessive daytime sleepiness.
- Changes in urinary habits such as increased urination at night, trouble starting your urine stream, passing urine many times during the day, having an urge that you have to go to the bathroom right away, having a urine accident, being unable to pass urine and weak urine flow.

The major risks of AndroGel include:

Prostate Disorders: Patients treated with testosterone may be at an increased risk for prostate enlargement, and prostate cancer. Talk to your healthcare provider for more information on risk factors and ways to monitor for prostate disorders.

Testosterone Transfer: Transfer of testosterone to others (including women and children) can occur when vigorous skin-to-skin contact is made with the application site. AndroGel must not be used by women, and exposure to the active ingredient testosterone in pregnancy can cause fetal harm. Notify your healthcare provider if your female partner develops changes in hair distribution, increases in acne or other signs of masculinity.

6. How Should AndroGel Be Stored?

Store at 25°C (77°F); excursions permitted to 15° to 30°C (59° to 86°F) [see USP Controlled Room Temperature]. Keep out of the reach of children.

7. Is There Anything Else I Need To Know When Using AndroGel?

Your healthcare professional has prescribed AndroGel to meet your specific needs; never share your AndroGel with anyone. If you have any questions or concerns about your AndroGel treatment, ask your healthcare provider or pharmacist.

Revised: December 2007

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Solvay Pharmaceuticals, Inc.
Marietta, GA 30062-2224

U.S. Patent No. 6,503, 894

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Marine Minesweepers

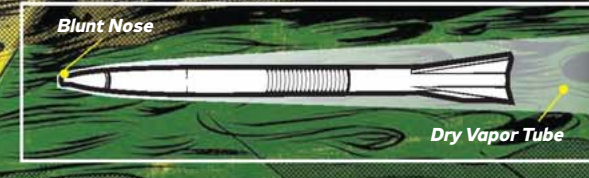
CANNONS CAPABLE OF FIRING UNDERWATER MAY BE THE NAVY'S BEST TOOL FOR CLEARING UNDERWATER MINES.

BY DAVID HAMBLING

Low-tech underwater mines are easy to place undetected, but are powerful enough to damage modern warships. To clear these hazards, Northrop Grumman is developing a helicopter-based technology, called the Rapid Airborne Mine Clearance System (RAMICS). It locates mines with laser scanners and destroys them with supercavitating cannon rounds that can cut through water (which is about a thousand times as dense as air), thanks to a carefully designed blunt tip. "The tip creates a shock wave that vaporizes the water ahead of the projectile," says Bob Klein, vice president of maritime and tactical systems for Northrop Grumman. The round effectively travels inside a dry tube of vapor slightly wider than itself, and can detonate mines at depths greater than 40 feet. The next stage in the program is to mount the gun and sensor on an MH-60 helicopter for flight testing. Development should be complete in 2013, with the system entering service in 2015.

Gun
The RAMICS gun is 11 feet long and fires 200 shots per minute.

Projectile
A blunt nose creates a shock wave that vaporizes the drag-inducing water around the projectile.



Laser
A helicopter-mounted laser scans the depths for mines and targets the gun.

Other Water Weapons

Anti-Mine Darts

The Navy's Countermine System is a 2000-pound guided bomb that releases more than 4000 darts to clear mines from beaches and surf. Each dart has a supercavitating nose that allows it to punch through more than 10 feet of water. The system should be fielded by 2016.

Submerged Firearms

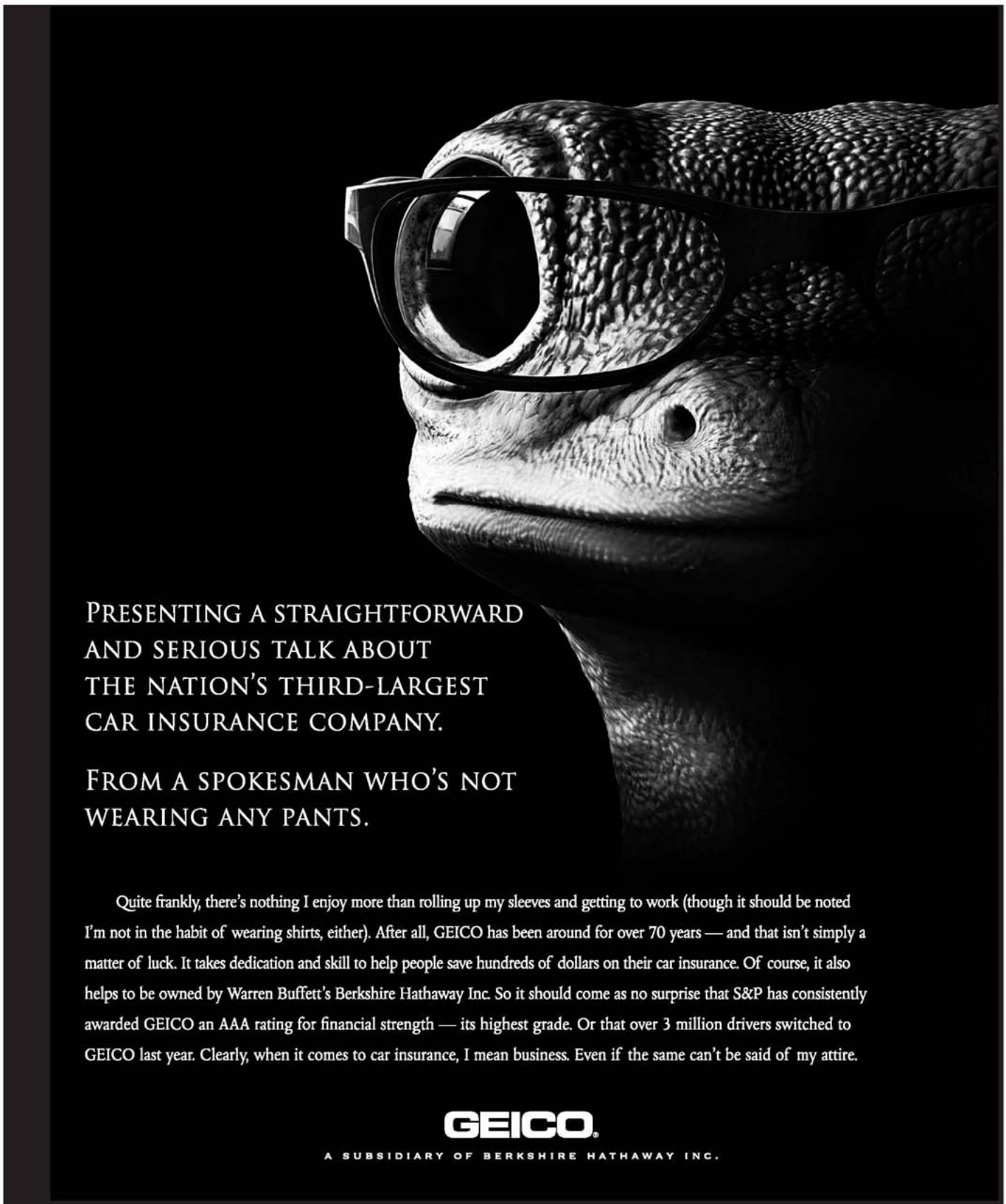
In the '60s, the Soviet military introduced the SPP-1 underwater pistol, which allowed combat divers to fire blunt-nosed ammunition effective out to 56 feet at shallow depth. The NATO equivalent is the Heckler & Koch HK P11.

Sewer Rifles

To protect the network of sewers under the Kremlin, specially trained Russian combat divers are armed with an underwater assault rifle, the APS.

ILLUSTRATION BY BRADLEY R. HUGHES (PROJECTILE)

ILLUSTRATION BY **WESLEY ALLSBROOK**



Quite frankly, there's nothing I enjoy more than rolling up my sleeves and getting to work (though it should be noted I'm not in the habit of wearing shirts, either). After all, GEICO has been around for over 70 years — and that isn't simply a matter of luck. It takes dedication and skill to help people save hundreds of dollars on their car insurance. Of course, it also helps to be owned by Warren Buffett's Berkshire Hathaway Inc. So it should come as no surprise that S&P has consistently awarded GEICO an AAA rating for financial strength — its highest grade. Or that over 3 million drivers switched to GEICO last year. Clearly, when it comes to car insurance, I mean business. Even if the same can't be said of my attire.

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Some discounts, coverages, payment plans, and features are not available in all states or in all GEICO companies. GEICO auto insurance is not available in Mass. On December 31, 2007 Government Employees Insurance Company had admitted assets of $12.9 billion, and policyholder surplus of$5.1 billion (including $33.4 million in paid up capital stock). Total liabilities were $7.8 billion, including $7.1 billion in reserves. Additional financial information is available at: http://www.geico.com/about/corporate/financial-information/. GEICO (Government Employees Insurance Company) is the third-largest private passenger auto insurer in the United States based on the latest 12-month written premium through June 2008. • Government Employees Insurance Co. • GEICO General Insurance Co. • GEICO Indemnity Co. • GEICO Casualty Co. GEICO: Washington, DC 20076. GEICO Gecko image © 1999 – 2009. © 2009 GEICO

Upgrade

Bed Maker

Gas-powered tillers aren't the dirtiest tool in the shed—their four-stroke engines are cleaner than the two-strokes used in leaf blowers, string trimmers and chain saws—but they still spew fumes. Not the cordless **Husqvarna TB 1000 Battery Cultivator ($900)**. It's nearly silent, runs smoother than a gas tiller and can operate for 45 minutes on a charge. And while it's not quite as powerful as its gas-powered cousins, its 9-inch tines can be adjusted up to 18.5 inches wide, allowing it to turn more than enough dirt for a typical homeowner's flower bed or vegetable patch. *— SETH PORGES*



PHOTOGRAPH BY **MICHAEL COGLIANTRY**

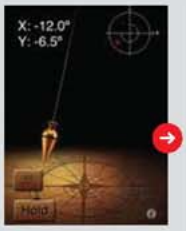
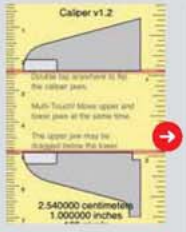
wish list

Test Drive

iPHONE TOOL APPS



There are iPhone apps for just about everything. So it's not surprising that the Apple App Store has a whole crop of programs aimed at simulating household tools, many of which make use of the iPhone's built-in accelerometer. We took a look at three programs that are meant to replace measuring and leveling tools, and gave them to PM's senior home editor, Roy Berendsohn, to test. Can an all-in-one tech product replace (some of) your carpentry toolbox? — *SETH PORGES*

	the promise	*roy's take*	*bottom line*
 iHANDY CARPENTER PLUMB BOB ($1.99)	Carpenters use string-suspended plumb bobs to make sure their constructions are vertically true. This app uses the iPhone's accelerometer—as the phone tilts, an animated bob swings, revealing how far off plumb you are.	Because the iPhone has no inherent ability to find plumb, it must be calibrated on a known plumb surface. "But you'd need to measure whether it's plumb first, and if you have those tools, why would you use this?" Roy says.	Practically useless. Even if you can calibrate the phone, it can't be suspended from a string, preventing it from hanging from a ceiling.
 STANLEY LEVEL (Free)	You may have seen a virtual spirit level in one of the iPhone's ads. This version comes from real-life toolmaker Stanley. (Much like the plumb bob, it must be calibrated on a surface known to be level.)	Real levels have flat edges, so they can stand on their own. The iPhone's edges are rounded, forcing you to keep a constant hold on the phone. "I'd much rather use a real level that uses gravity as a calibration tool," Roy says.	The level is fun to show off at parties, and better than nothing in a pinch. But don't try to build a house with it.
 CALIPER ($0.99)	This caliper app measures the length of real-world objects. You use your finger to drag the virtual jaws to the edges of the object you want to measure, then read the digital display.	Caliper jaws grip an object's edges, providing precise measurements. The iPhone app makes you eyeball it. "A caliper is a precision instrument, so what good is it if it isn't precise?" Roy says.	The program is passable as a stand-in for a small ruler, but don't use it for DIY projects, or anything that requires exact measurements.

Light Bright

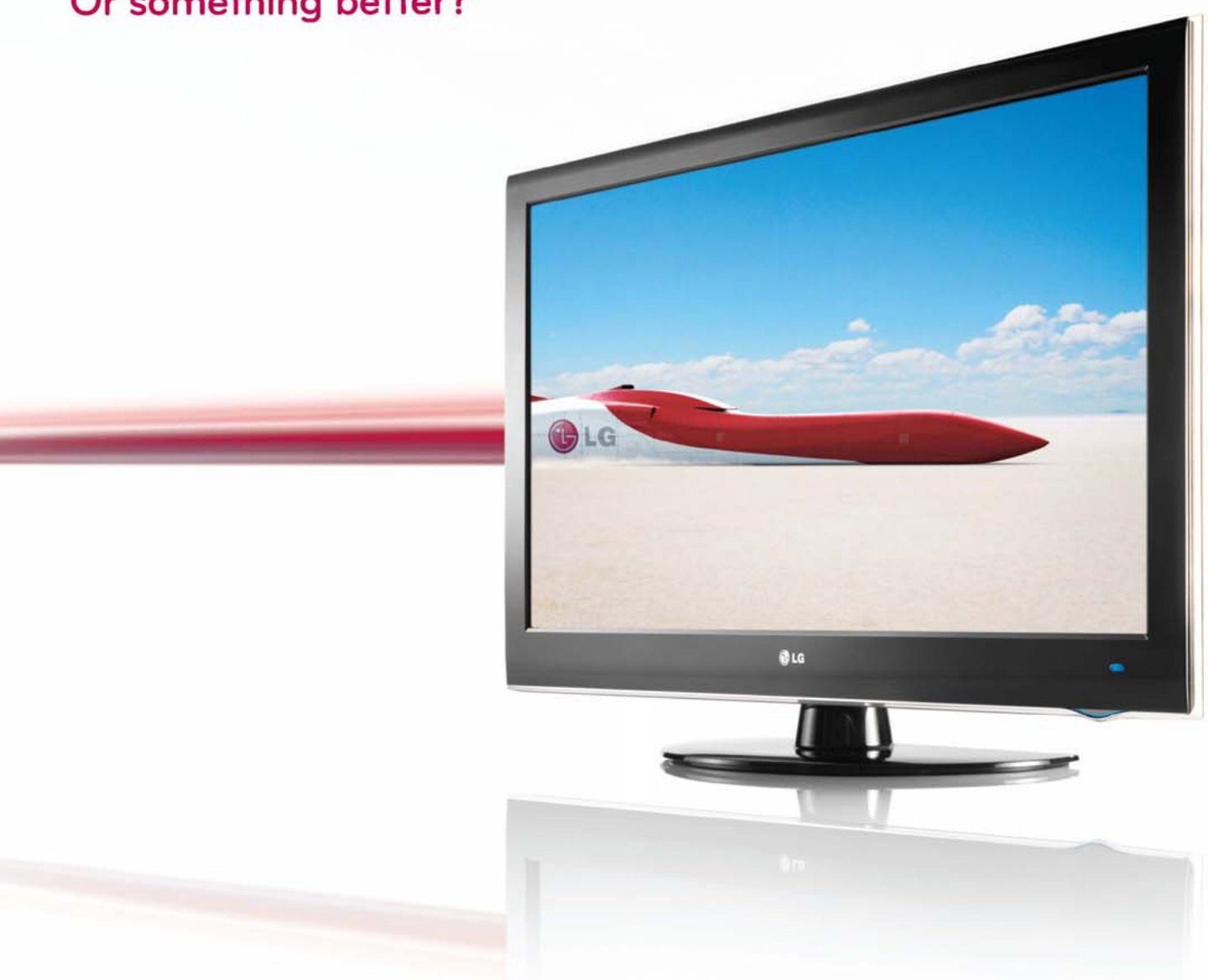
For amateur photographers, a snap-on hot-shoe flash is one of the quickest ways to give pictures a pro-like polish. But decent flashes tend to be bulky and can cost almost as much as an entry-level SLR camera. The Canon Speedlite 270EX ($160) possesses the key features that characterize the best flashes—including the ability to swivel to let shooters bounce light off walls and ceilings, and a quick 3.9-second recycling time—in a surprisingly compact body. And it costs about half as much as comparable flashes.



Is it a TV?

When your eyes can follow a rocket car test run and still notice a paint scratch on the rear fin, it must be the LG 240Hz TV. The one that delivers your need for speed with a crystal clear picture – so you'll never miss a second of the action.

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The LG LCD TV with TruMotion 240Hz. It keeps up with all the action frame by frame to bring you unsurpassed motion detail. **LGusa.com/240Hz**

LG
Life's Good

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Freestyle Rap

Just pliers and a knife. Not even a little screwdriver, no bottle opener, nothing. But do you need all that junk? The 4.5-ounce Leatherman Freestyle CX ($60) does just two things, and it does them well. The knife stays open with no wiggly slop. The pliers are so precisely machined that, when shut, the needle-nose tips look like a single piece of steel. And the lack of frills makes for one tiny tool—we slipped it into a pocket one day and honestly forgot it was there. The steel corners could wear a hole in jeans, but maybe that explains the overlooked third function: the belt clip.





Power Vacuum

The tighter the bond between a vacuum's head and the floor, the stronger its suction. Most vacuums create this seal with sheer (and often cumbersome) weight, which increases the pressure against the floor. The ***Dyson DC28 Animal Vacuum ($600)*** uses a piston-driven pneumatic seal to force the head against the ground without adding unnecessary pounds. And yes, this thing can suck. Its shockingly powerful pull was enough to nearly drag our testers off their feet. While the price tag is steep, we're definitely hoping this feature works its way down into cheaper vacuums before long.



Curvy Clipboard

Clipboards are a work-site staple. Unfortunately, their straight bottoms are better suited for resting on a desk than against your stomach. The Oxo Good Grips Clipboard ($8) features a belly-friendly concave base that wraps around your midsection, making it comfortable for hours of gut-steadied writing. And the nonslip covering keeps papers from slipping.



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Getting Started

WAKE-BOARDING



Skilled wakeboarders skate across the water's surface at 25 mph before flying as high as 8 feet in the air. But the intensity of wakeboarding masks the fact that it's actually pretty easy to learn. "By the end of the first day you'll be able to hit the wake and get some air, no problem," 16-year veteran wakeboarder Zane Schwenk says. Here are the skills and gear you need to get started.

BY MARK ANDERS



The trick is called a roast beef—it's a midair, between-the-legs grab of the back of the board. Practice, and maybe one day ...

the skills

STANDING UP



1. Start in the water, floating on your back with the board perpendicular to the rope. Your arms should be around your bent knees, with both hands gripping the handle (like a baseball catcher's squat). Keep your eyes focused on the boat.



2. As the boat begins to pull, let your hips slide to your ankles and your chest to your knees. Don't muscle it—the boat will pull you up. Slowly rise with your back straight, move the handle in front of your lead hip and let the board turn until it's in line with the towrope.



3. While riding, keep your knees bent slightly with your chest up and hold the handle in front of your leading hip. "Let the boat do all the work," Schwenk says.

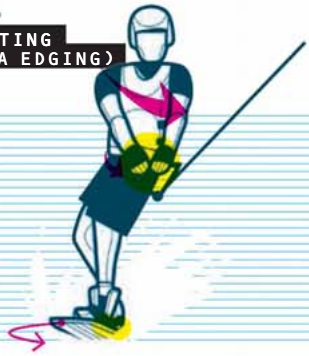
JUMPING THE WAKE

Now for the fun part: getting air. Amateur jumpers should shorten the rope to around 55 or 60 feet. "The shorter your rope, the narrower the wake, so you can jump it a lot easier," Watson says.

1. As you begin to cut toward the wake, fix your gaze on an object across it. Gradually increase the speed and angle of your cut as you approach the wake, and extend your knees fully as you hit the top.

2. Raise your front foot up slightly so you don't bury the nose of the board when it lands. As you fly, keep your chest up and bend your knees to turn them into impact-absorbing shocks.

CUTTING (AKA EDGING)



1. To swipe back and forth across the wake, turn your shoulders and hips so they are more open to the boat. Look where you want to go and move the handle slightly to the inside of your forward-facing hip, while transferring your weight to your heels.



2. As you cross the wake, keep your knees bent. "Don't steer with the rope," says Shawn Watson, two-time national wakeboarding champion. "Keep the rope at your hip and your arms straight. It's more of a lower-body movement."



3. To cut back in the other direction, slowly press your toes down and push your knees forward toward the water. Turn your shoulders and hips in the direction you want to cut.

PHOTOGRAPHS BY JOHN HUBA (WAKEBOARDER); KARL JUENGEL/STUDIO D (PRODUCTS); ILLUSTRATIONS BY GABRIEL SILVEIRA

the gear



1. Helmet
Pro-Tec Two Face ($70)

Most riders still eschew helmets, but they can be lifesavers. "Make sure it fits snug so it doesn't catch the water and 'bucket' when you fall," Schwenk says.

2. Personal Flotation Device
CWB Essential Vest ($80)

The best wakeboarding vests are neoprene with segmented foam for flexibility, Watson says. Vests stretch out in the water, so look for a snug fit.

3. Boots and Binding
CWB Torq ($245)

The most important factor in a binding is how easy it is to slip your foot in and out. This set has a hinge system that flips down for easy entry. And while most boots and bindings fit a range of sizes, it's best to choose one that closely matches your street-shoe size. "Lots of injuries come from loose heels," Schwenk says.

4. Board
Liquid Force Trip ($260)

Beginners should look for a board with gently rounded rails and medium-size fins—it will be easy to handle, yet the rider won't outgrow it after a little practice.

5. Rope and Handle
Straight Line Benny G Rope ($130), Straight Line Benny G Pro Handle ($80)

Nonstretch urethane-coated ropes like this are the gold standard, and the handle's EVA foam grip negates the need for gloves.

6. Boat
MasterCraft X-1 ($53,390)

While you can ride behind just about anything that can pull you at 25 mph, the best wakeboarding boats have inboard motors (their wakes are cleaner and crisper than an outboard motor's relatively frothy output, which can easily catch board tips), a tow tower for added upward lift, ballast tanks to add weight for a larger wake, and cruise control to keep wakeboarders at a steady speed. MasterCraft's X-1 features a 310-hp (upgradable to 350) 5.7-liter engine, is built around the world's best-selling wakeboard hull, and is known for producing thick, well-defined wakes.

tip

Dry-Land Practice: *Before hitting the lake, sit on the ground in the catcher position with your feet shoulder-width apart, knees together and arms straight, holding the handle. Have a friend be the boat and slowly pull the rope until you stand up.*

extreme freebie!



Win This Harley-Davidson XR1200

Few motorsports are as definitively American as flat-track racing. And the Harley-Davidson XR-750 dominated the sport. This year, Harley launches an homage to that legendary machine: the $10,799 XR1200. The XR1200 injects some mojo into the Sportster line with a more powerful engine and an aggressive suspension. For the traditional, air-cooled, pushrod 1200-cc V-twin, Harley bumped the compression ratio to 10:1 and added performance cams and electronic fuel injection. It's comfortable, easy to ride and exudes the kind of character that could only come from Harley-Davidson. The first batch of 750 bikes is available in Harley's classic orange-and-black livery. We're so smitten by this bike, we asked Harley if they could give one away to a lucky PM reader. You can win one and receive Harley-Davidson Rider's Edge training (where available) too. To enter and to read all the contest rules go to *popularmechanics.com/harleysweeps*. — BEN STEWART



- **Random Draw Sweepstakes: No purchase necessary to enter or win. Harley XR1200 Giveaway. Sponsored by Hearst Communications, Inc.**
- **Beginning June 2, 2009, at 12:01 am (ET), through July 13, 2009, at 11:59 pm (ET), go to *www.popularmechanics.com/harleysweeps* and complete and submit the entry form pursuant to the online instructions. Odds of winning will depend upon the total number of eligible entries received. Must be a legal resident of the 50 United States, the District of Columbia or Canada who has reached the age of majority in his or her state or province of residence at time of entry. Void in Puerto Rico, the province of Quebec and where prohibited by law. Sweepstakes subject to complete official rules, available at *www.popularmechanics.com/harleysweeps*.**


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Sturdy enough to handle heavy objects and precise enough to hold on to the smallest items: Adaptability is what this machine is all about. You can stop and clamp the Jawhorse anywhere along its 37" capacity. From the thickness of a playing card to the width of a standard door (up to 37") and even a full 4' x 8' sheet of plywood (with the addition of the Plywood Jaw), this machine clamps everything with sturdy precision. It's so precise, in fact, that it can even securely clamp a raw egg without breaking it.





Portable and sets up in seconds: The Jawhorse is as easy to set up as a folding chair. Its three legs and foot pedal easily fold out to create a sturdy work surface even when the ground is uneven. You're ready to work in seconds wherever the job is —your shop, your driveway, your backyard or the jobsite. It even has a built-in roller for quick and easy transport.

Try a Jawhorse™ risk free for 30 days: There's nothing to lose except the aggravation of not having one. It will quickly become your go-to tool whenever you start a project. To learn more, visit www.JAWHORSE.com to watch a video, and to see all of the great Jawhorse accessories for everything from cutting timber to welding.

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New Cars

2010 ***VW GTI***
Base Price
(Est): $25,000

pm test driven

++



Prime Mover

The GTI's primary objective is simple—deliver a high-octane hoot at a reasonable price. And the new GTI hits that mark easily. The car feels familiar from behind the wheel, since it shares much with its immediate forebear. The smooth, elastic power delivery of the 207-hp turbocharged Four is a treat, as is the profound surge of acceleration that greets a deep dig at the throttle. But the GTI now combines that friskiness with unexpected poise, bridging the gap between affordable fun and sophisticated motoring. As a nod to GTI tradition, the grille incorporates a red stripe and the cloth seats are hipster plaid. The GTI's enviable combination of sportiness, solidity and economy (an estimated 32 mpg) should dispel any notion that GTIs are merely rude performance hatchbacks. *— BARRY WINFIELD*

INSIDE:

Triumph Bonneville SE • Lamborghini LP 560-4 Spyder
Ford Mustang Shelby GT500 • Audi S5 Cabriolet



1 2009 **Triumph Bonneville SE** 2 2009 **Lamborghini LP 560-4 Spyder**

Old-School

Triumph's retro Bonneville has successfully captured the look and flavor of one of the world's most iconic motorcycles. The new $8399 SE model gains fuel injection, alloy wheels, a lower seat and dual megaphone-style exhausts—just like the sporty Thruxton. The 865-cc motor creates a broad, flat plateau of torque, so downshifts are seldom needed for passing maneuvers. A good rider on a Bonneville SE will surprise a few sportbikes in the right circumstances. But this Bonnie's real forte is the easygoing Sunday cruise. The big twin generates 51 lb-ft of torque, so it's smooth and relaxed at moderate engine speeds, with just enough of a mechanical pulse coming through to provide the right ambience. *— BARRY WINFIELD*

Dream Weaver

How does Lamborghini improve the already fierce LP 560-4? Ditch the roof. The 552-hp Spyder commands a staggering $224,700 price tag. And that's not counting the $10,000 eGear transmission, or goodies like the $26,000 matte paint. Yikes. So our drive on Tenerife—the largest of the Canary Islands—was like Lamborghini fantasy camp. Driving from sea level to the top of the Pico de Teide volcano, the highest point in Spain, we encountered plenty of hairpin turns to challenge the Spyder's chassis. Once the front tires bite and the suspension settles, grip from all four is extreme. And that sonorous exhaust note spills onto the landscape, making any public road sound like Le Mans. The flow of combusted exhaust gases produces an aural mashup that's just as intoxicating as the engine's incredible thrust. *— BASEM WASEF*

The fabric-roofed Gallardo receives chassis reinforcements including front and rear firewall beams and beefed-up rocker panels—all designed to improve stiffness. It takes four hydraulic motors and 20 seconds for the rear bonnet to lift and the canvas roof to fold flush beneath the artfully scooped and vented decklid.

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Introducing the PowerCone® metal polishing tool from Mothers®. Its unique conical shape is ideal for getting into those tight, difficult-to-reach areas. And its long tapered side is perfect for polishing broad, curved surfaces. Plus, you get to use it with a drill. Life is good. **Visit us at Mothers.com**











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Diesel Motor Oil Update from Shell Lubricants

What are the benefits of using current-generation motor oil in a diesel engine?

It has been more than two years since API CJ-4 diesel engine oil was introduced for diesel engines. In the past, when a new API-category diesel motor oil was introduced, the previous category was typically discontinued. Today, both API CJ-4 and the previous-category API CI-4 PLUS diesel engine oils are available.

However, there are many benefits to using the latest technology found in API CJ-4 motor oil. Each new generation of motor oil provides incremental improvements and benefits for your diesel engine. API CJ-4 motor oils, such as Shell Rotella® T with Triple Protection® technology, provide a significant leap in wear protection, soot and deposit control, and high-temperature stability over API CI-4 PLUS motor oils.

API CJ-4 motor oils were designed to meet the needs of the newest generation of engines, built beginning in 2007, as well as provide improved protection for engines built prior to 2007. API CJ-4 motor oils are recommended in 2007-and-later on-highway diesel engines to allow for the maximum durability of exhaust after-treatment devices such as a Diesel Particulate Filter (DPF).

In pre-2007 engines, API CJ-4 motor oil provides the latest protection. Based on extensive industry-recognized engine-wear tests, Shell Rotella® T with Triple Protection® technology provides on average 50% greater wear protection (ranging from 27% to 88% reduced wear) than the previous formulation. These laboratory-based findings are backed up by the results of 40 million miles of on-highway road testing using pre-2007 engines in which significantly lower iron wear was found.

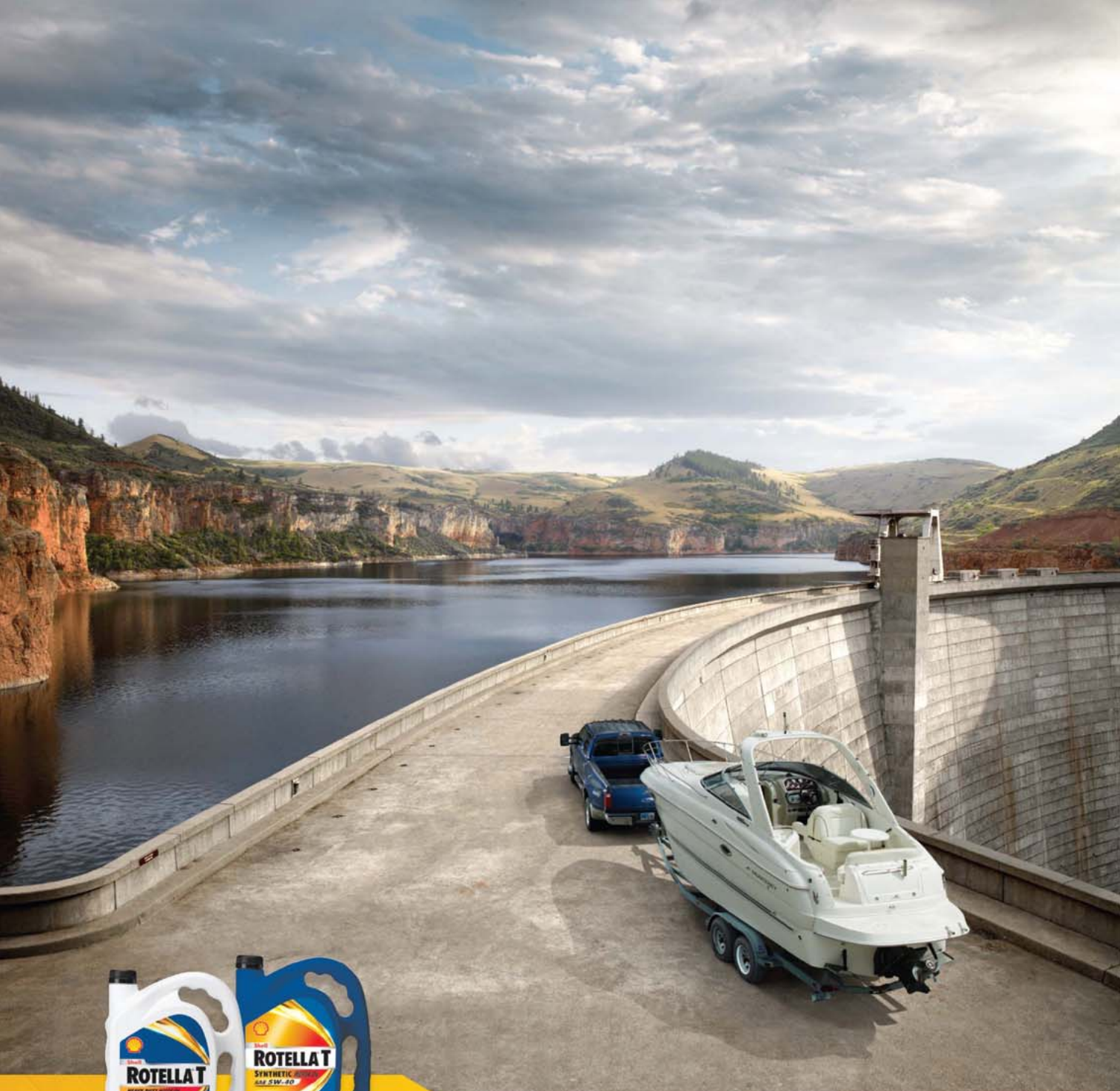
Engines using this higher-performance motor oil should experience significantly less wear in the valve-train and power-cylinder areas of the engine, which can promote long engine life. In addition, API CJ-4 motor oil provides increased protection against heat and increased soot-handling capabilities, which can enhance engine cleanliness and engine durability.

What are the benefits of using synthetic diesel motor oil?

Synthetic motor oil such as Shell Rotella® T Synthetic SAE 5W-40 helps keep the engine clean through improved sludge, deposit and varnish protection, and helps reduce overall engine wear under extreme operating conditions. Synthetic motor oils typically provide better protection when the engine is running under high-temperature conditions, such as heavy towing and hauling. Shell Rotella® T Synthetic SAE 5W-40 motor oil can help improve fuel efficiency by up to 1% compared to conventional SAE 15W-40 motor oil by decreasing friction and reducing the energy used to pump the oil through the engine.



The term 'Shell Lubricants' collectively refers to the various Shell companies of Royal Dutch Shell PLC that are engaged in the lubricants business.



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When the one thing standing between you and the job site is long, steep and dusty, are you going to tackle it with confidence? You will with Shell Rotella® T 15W-40 with Triple Protection™ technology and Shell Rotella® T Synthetic 5W-40 motor oils. Both meet or exceed API CJ-4 requirements for protection in extreme environments. Go ahead and haul that heavy load. You've got performance to spare. **Shell Rotella® T. It belongs in your truck.®**

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Snake Charmed

The new Camaro is the darling of the muscle car set. But can the Mustang Shelby GT500 bury it in a cloud of tire smoke? We brought our VBOX test gear to Infineon Raceway in Sonoma, Calif., to find out. Before we hit the track, we had a chance to drive the GT500 on the nearby mountain roads where this Mustang simply shone. There's a certainty to the car's handling that was missing before. It cuts into corners confidently and crisply, yet it has more of the visceral thrill we want in a pony car. The supercharger is quieter now, so the burbly exhaust is more audible. The steering is quick and light. Back at the track, a stiff head wind gusted straight down the dragstrip, so our acceleration times are not perfect indicators of what the GT500 can do. Still, it was quick, trouncing the quarter-mile in 12.63 seconds. The Camaro SS we tested in Detroit ran a 13.0—flat. So in a drag race between the two, the much more expensive Shelby wins. *— LARRY WEBSTER*

the specs

BASE PRICE	$48,175
POWERTRAIN	540 hp/510 lb-ft 5.4-liter V8, 6M
SUSPENSION (F/R)	Independent strut/ solid axle, coil springs
WHEELBASE (IN.)	107.1
LENGTH (IN.)	188.2
WIDTH (IN.)	73.9
AXLE RATIO	3.55:1
BRAKES (F/R, IN.)	14.0 disc/11.8 disc
TIRES (F/R)	P255/40ZR19 P285/35ZR19
ACCELERATION (SEC)	
0–30 MPH	2.07
0–60 MPH	4.55
0–100 MPH	9.93
40–70 MPH	2.84
1/4-MILE	12.63@113.25 mph
BRAKING (FT)	
30–0	28.51
60–0	114.42
SKIDPAD (G'S)	0.92
EPA FUEL ECONOMY (MPG)	
CITY	14
HIGHWAY	22



The Shelby has the world's most perfect shifter—a white cue ball that fits perfectly in your hand to access the six-speed.



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2010 **Ford Mustang Shelby GT500**



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PLAVIX can help save lives for those who've had a heart attack caused by a completely blocked artery.



Clots that block off arteries are the main cause of heart attack. And now that you've had a heart attack you are at a greater risk of having another that can be fatal. That's why your doctor may put you on PLAVIX, along with your other heart medicines. Taking PLAVIX with your other heart medicines goes beyond what other heart medicines alone can do to keep blood platelets from sticking together and forming dangerous clots.



IMPORTANT SAFETY INFORMATION: If you have a stomach ulcer or other condition that causes bleeding, you should not use PLAVIX. When taking PLAVIX alone or with some other medicines including aspirin, the risk of bleeding may increase so tell your doctor before planning surgery. And, always talk to your doctor before taking aspirin or other medicines with PLAVIX, especially if you've had a stroke. If you develop fever, unexplained weakness or confusion, tell your doctor promptly as these may be signs of a rare but potentially life-threatening condition called TTP, which has been reported rarely, sometimes in less than 2 weeks after starting therapy. Other rare but serious side effects may occur.

Ask your doctor how PLAVIX can help increase your protection against future heart attack, stroke, and even death.

To learn more about heart attacks and PLAVIX, visit www.plavix.com or call 1-800-230-6290.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

See important product information on the following page.

If you need help paying for prescription medicines, you may be eligible for assistance. Call 1-888-4PPA-NOW (1-888-477-2669), or go to www.pparx.org

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(clopidogrel bisulfate) 75mg tablets

WHO IS PLAVIX FOR?
PLAVIX is a prescription-only medicine that helps keep blood platelets from sticking together and forming clots.

PLAVIX is for patients who have:
- had a recent heart attack.
- had a recent stroke.
- poor circulation in their legs (Peripheral Artery Disease).

PLAVIX in combination with aspirin is for patients hospitalized with:
- heart-related chest pain (unstable angina).
- heart attack.

Doctors may refer to these conditions as ACS (Acute Coronary Syndrome).

Clots can become dangerous when they form inside your arteries. These clots form when blood platelets stick together, forming a blockage within your arteries, restricting blood flow to your heart or brain, causing a heart attack or stroke.

WHO SHOULD NOT TAKE PLAVIX?
You should NOT take PLAVIX if you:
- are allergic to clopidogrel (the active ingredient in PLAVIX).
- have a stomach ulcer
- have another condition that causes bleeding.
- are pregnant or may become pregnant.
- are breast feeding.

WHAT SHOULD I TELL MY DOCTOR BEFORE TAKING PLAVIX?
Before taking PLAVIX, tell your doctor if you're pregnant or are breast feeding or have any of the following:
- gastrointestinal ulcer
- stomach ulcer(s)
- liver problems
- kidney problems
- a history of bleeding conditions

WHAT IMPORTANT INFORMATION SHOULD I KNOW ABOUT PLAVIX?
TTP: A very serious blood condition called TTP (Thrombotic Thrombocytopenic Purpura) has been rarely reported in people taking PLAVIX. TTP is a potentially life-threatening condition that involves low blood platelet and red blood cell levels, and requires urgent referral to a specialist for prompt treatment once a diagnosis is suspected. Warning signs of TTP may include fever, unexplained confusion or weakness (due to a low blood count, what doctors call anemia). To make an accurate diagnosis, your doctor will need to order blood tests. TTP has been reported rarely, sometimes in less than 2 weeks after starting therapy.

Gastrointestinal Bleeding: There is a potential risk of gastrointestinal (stomach and intestine) bleeding when taking PLAVIX. PLAVIX should be used with caution in patients who have lesions that may bleed (such as ulcers), along with patients who take drugs that cause such lesions.

Bleeding: You may bleed more easily and it may take you longer than usual to stop bleeding when you take PLAVIX alone or in combination with aspirin. Report any unusual bleeding to your doctor.

Geriatrics: When taking aspirin with PLAVIX the risk of serious bleeding increases with age in patients 65 and over.

Stroke Patients: If you have had a recent TIA (also known as a mini-stroke) or stroke taking aspirin with PLAVIX has not been shown to be more effective than taking PLAVIX alone, but taking aspirin with PLAVIX has been shown to increase the risk of bleeding compared to taking PLAVIX alone.

Surgery: Inform doctors and dentists well in advance of any surgery that you are taking PLAVIX so they can help you decide whether or not to discontinue your PLAVIX treatment prior to surgery.

WHAT SHOULD I KNOW ABOUT TAKING OTHER MEDICINES WITH PLAVIX?
You should only take aspirin with PLAVIX when directed to do so by your doctor. Certain other medicines should not be taken with PLAVIX. Be sure to tell your doctor about all of your current medications, especially if you are taking the following:
- aspirin
- nonsteroidal anti-inflammatory drugs (NSAIDs)
- warfarin
- heparin

Be sure to tell your doctor if you are taking PLAVIX before starting any new medication.

WHAT ARE THE COMMON SIDE EFFECTS OF PLAVIX?
The most common side effects of PLAVIX include gastrointestinal events (bleeding, abdominal pain, indigestion, diarrhea, and nausea) and rash. This is not a complete list of side effects associated with PLAVIX. Ask your doctor or pharmacist for a complete list.

HOW SHOULD I TAKE PLAVIX?
Only take PLAVIX exactly as prescribed by your doctor. Do not change your dose or stop taking PLAVIX without talking to your doctor first.

PLAVIX should be taken around the same time every day, and it can be taken with or without food. If you miss a day, do not double up on your medication. Just continue your usual dose. If you have any questions about taking your medications, please consult your doctor.

OVERDOSAGE
As with any prescription medicine, it is possible to overdose on PLAVIX. If you think you may have overdosed, immediately call your doctor or Poison Control Center, or go to the nearest emergency room.

FOR MORE INFORMATION
For more information on PLAVIX, call 1-800-633-1610 or visit www.PLAVIX.com. Neither of these resources, nor the information contained here, can take the place of talking to your doctor. Only your doctor knows the specifics of your condition and how PLAVIX fits into your overall therapy. It is therefore important to maintain an ongoing dialogue with your doctor concerning your condition and your treatment.

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❶ 2010 **Audi S5 Cabriolet**

Pole Position

Fifty degrees and raining isn't exactly Cabriolet weather, but we're in Monaco, so the top must go down—we won't let a little rain douse our plans to play junior-league race driver. Besides, the S5 pipes warm air around your neck to keep things toasty. It's easy to fall for the torquey, supercharged V6, particularly when it's paired to the seven-speed dual-clutch transmission. As we bomb toward the Grand Hotel hairpin, four quick toggles of the left paddle produce downshifts and fuel our inner Schumacher. You can feel the sport differential squelching understeer as you unwind the wheel for the straight. There's a race-car-like *pop* between each ultraquick upshift, further solidifying our F1 fantasies. — *JAMES TATE*

Check the option box for Audi's Drive Select, and you'll be able to vary steering and throttle response, as well as shock stiffness, transmission shift points and even the tenacity of the aforementioned sport differential with the push of a button. The Quattro all-wheel-drive system now has a 40:60 torque distribution, to help mimic rear-drive.

FIRST LOOK:

❷ 2011 **Tesla Model S**

Fully Charged

It's not hard to find the drawbacks of Tesla's electric Roadster. Though the sports car is quick, its two-seat configuration and $109,000 price tag help keep it out of most garages. But Tesla CEO Elon Musk wants the Model S to change that. By late 2011, Tesla plans to offer an electric sedan that seats seven and hits 60 mph in under 6 seconds. The standard 42-kilowatt-hour battery pack is said to contain roughly 8000 lithium-ion cells—the Roadster uses 6831. On a per cell basis, the batteries are estimated to produce a 20 percent volumetric improvement in efficiency over the Roadster. Batteries will be available in 160-mile, 230-mile or 300-mile ranges, with the sedan's $57,400 price tag based on the entry-level 160-mile-range setup. That's not an inexpensive automobile. But the figure does dip to $49,900 after the maximum $7500 federal tax credit for electric vehicles kicks in. Tesla seems to have weathered some serious technical challenges that plagued its Roadster, and the Model S appears promising. But, looking ahead, a ramp-up of EVs and plug-in hybrids from the major automakers could challenge Tesla's turf. — *BASEM WASEF*



New York



The uncertainty of Detroit's future meant there was a distinct lack of glitz at the 2009 New York International Auto Show in April. Product reveals were less splashy, and executives spoke about new cars in measured tones. In fact, just three weeks later, GM announced it would close the Pontiac brand. But even in these tough times, there were still exciting vehicles. Here are six of the most significant. *— BEN STEWART*

Production

1. *2011 Jeep Grand Cherokee*
The new Grand Cherokee is based on the Mercedes-Benz ML four-wheel independent chassis. A new Quadra-Lift air suspension varies ground clearance from 8.1 inches to 11.1 inches. A new 280-hp 3.6-liter V6 delivers 11 percent better fuel economy, while the 360-hp Hemi V8 returns as the top engine.

2. *2010 GMC Terrain*
The Terrain is GMC's version of the Chevy Equinox crossover. A 182-hp 2.4-liter four-cylinder with direct fuel injection will deliver 21 mpg city and 30 mpg on the highway. A more powerful 264-hp 3.0-liter V6 is also available.

3. *2010 Subaru Outback*
The Outback was a crossover pioneer when it arrived in 1996. This all-new version is considerably larger and roomier than the current model. When it goes on sale this summer, it will only be available with a 2.5-liter 170-hp flat Four or a 3.6-liter 256-hp opposed six-cylinder—and, sadly, no turbo-charged Four.

Concepts

4. *Acura ZDX Prototype*
Acura's ZDX, due this fall, walks the line between car and SUV even more closely than either its RDX or MDX crossovers. Acura says this is a four-door sport coupe. But thanks to the hatchback, it functions like a wagon too, offering more cargo flexibility.

5. *Scion iQ Concept*
The iQ is technically a concept. But expect to see this tiny Scion, based on the Europe- and Japan-only Toyota iQ, in stores soon—minus the 18-inch wheels and radically flared bodywork. Is America ready for a 55-mpg microcar? Perhaps.

6. *Hyundai Nuvis Concept*
The Hyundai Nuvis was one of only a handful of far-reaching concepts at the show—and the only hybrid. Hyundai will begin offering hybrids with the upcoming 2011 Sonata. This sleek concept shows that the automaker is considering the system for crossovers too.











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RAPID PROTOTYPING

> BY JAY LENO
> PHOTOGRAPHS BY JOHN LAMM

JAY'S SCANNER AND 3D PRINTER ALLOW HIM TO RE-CREATE OBSOLETE PARTS.

One of the hardships of owning an old car is rebuilding rare parts when there are simply no replacements available. My 1907 White Steamer has a feedwater heater, a part that bolts onto the cylinders. It's made of aluminum, and over the 100-plus years it's been in use, the metal has become so porous you can see steam and oil seeping through. I thought we could just weld it up. But it's badly impregnated with oil and can't be repaired. If we tried, the metal would just come apart.

So, rather than have a machinist try to copy the heater and then build it, we decided to redesign the original using our NextEngine 3D scanner and Dimension 3D printer. These incredible devices allow you to make the form you need to create almost any part. The scanner can measure about 50,000 points per second at a density of 160,000 dots per inch (dpi) to create a highly detailed digital model. The 3D printer makes an exact copy of a part in plastic, which we then send out to create a mold. Some machines can even make a replacement part in cobalt-chrome with the direct laser sintering process. Just feed a plastic wire—for a steel part you use metal wire—into the appropriate laser cutter.

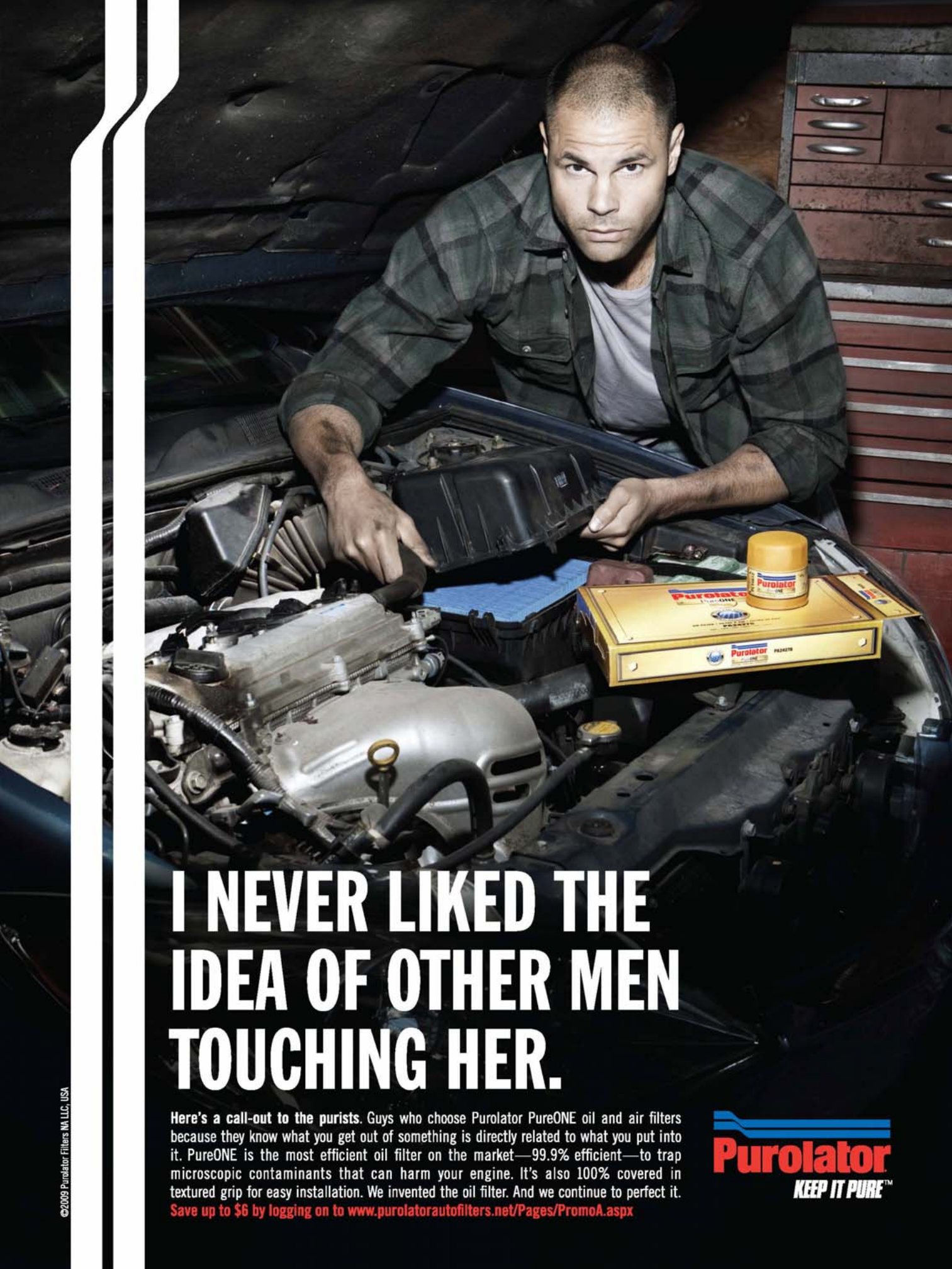
Inside the printer, the print head goes back and forth, back and forth, putting on layer after layer of plastic to form a 3D part. If there are any irregularities in the originals, you can remove them using software. Once the model is finished, any excess support material between moving parts is dissolved in a water-based solution. Complexity doesn't matter, but the size of the object does determine the length of the process. Making a little part might take 5 hours. The White's feedwater





↑ It's an amazing way to fabricate parts. The 3D scanner next to Jay creates a digital model of this flanged nut from Jay's EcoJet supercar. A 3D printer (above) uses the data to build a plastic replica.

→ The nut takes 20 minutes to scan and reverse model and 3 hours to print in plastic.



I NEVER LIKED THE IDEA OF OTHER MEN TOUCHING HER.

Here's a call-out to the purists. Guys who choose Purolator PureONE oil and air filters because they know what you get out of something is directly related to what you put into it. PureONE is the most efficient oil filter on the market—99.9% efficient—to trap microscopic contaminants that can harm your engine. It's also 100% covered in textured grip for easy installation. We invented the oil filter. And we continue to perfect it.
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heater required 33 hours.

Any antique car part can be reproduced with these machines—pieces of trim, elaborately etched and even scrolled door handles. If you have an original, you can copy it. Or you can design a replacement on the computer, and the 3D printer makes it for you.

People say, "Why not just give the part to your machinist to make?" Well, if the machinist makes it wrong, you still have to pay for it. The scanner allows you to make an exact copy in plastic, fit it and see that it's correct. Even when you take plans to a machinist, it can be tricky. Say the part must be 3 mm thick here and 5 mm there. You get it back and then, "Oh no, it doesn't fit; it's too thick," or "It's too thin." My setup lets you create the perfect part. And you could press the button again and again—and keep making the part—twice the size, half-size, whatever you need. If you have a part that's worn away, or has lost a big chunk of metal, you can fill in that missing link on the computer. Then you make the part in plastic and have a machinist make a copy based on that example. Or you can do what we do—input that program into a Fadal CNC machine; it reads the dimensions and replicates an exact metal copy.

Some guys are so used to working in the traditional ways. They're old-school. So they've never seen this new technology in use—in fact, they're not even aware it exists. When you work on old cars, you tend to work with old machinery like lathes, milling machines or English wheels. When someone tells you that you can take a crescent wrench, for example, scan it, then press a button, copy it, and make a new wrench, these guys say, "Well, that's not possible. You can't make the little wheel that moves the claw in and out. You'd have to make it in two sections."

But they're wrong. You can duplicate the whole tool.



YOU CAN TAKE AN ACTUAL CRESCENT WRENCH, FOR EXAMPLE, SCAN IT, THEN PRESS A BUTTON, COPY IT, AND MAKE A NEW WRENCH.

They stand in front of the machine and watch a wrench being made, and they still don't believe it. It's like *The Jetsons*. George Jetson would say, "I want a steak dinner." He'd press a button and the meal would come out of the machine, with the roasted potatoes and everything, all on one plate. We may not have the instant steak dinner yet—but my NextEngine system is like the car-guy equivalent.

If you had a one-off Ferrari engine, you could scan each part and then re-create the entire motor. Right now, we're scanning a Duesenberg body. It's a classic example of high tech melding with old tech. There are cars sitting in garages around the country, and they haven't moved in years for lack of some unobtainable part. Now they can hit the road once more, thanks to this technology.

My 1907 White engine would never have run again because its slide valve (or D-valve) was shot. We built that part, and now the car is back on the street.

Let's say you have an older Cadillac or a Packard, and you can't get one of those beautifully ornate door handles. You could go to the big swap meet in Hershey, Pa., every day for the rest of your life and never find it. Or you could take the one on the left side of your car, copy it, use the computer to reverse it, and put that new part on the other side.

It's an amazingly versatile technology. My EcoJet supercar needed air-conditioning ducts. We used plastic parts we designed, right out of the 3D copier. We didn't have to make these scoops out of aluminum—plastic is what they use in a real car. And the finished ones look like factory production pieces.

When I was in high school, a friend's father bought the new Pulsar LED watch. He paid $2200 for it. It had a red face; you pressed a button, it lit up and gave you the time. The next year I bought a similar watch from Texas Instruments for $19.99. I went over and showed it to my friend's dad, and he was *sooo* angry.

The NextEngine scanner costs $2995. The Dimension uPrint Personal 3D printer is now under $15,000. That's not cheap. But this technology used to cost 10 times that amount. And I think the price will come down even more.

These machines are not suited for mass production, but they work well for rapid prototyping. Just as eBay has made many swap meets go away, this machine could eliminate the need to go to eBay for parts. Think about it: What old part do you want to make? **PM**

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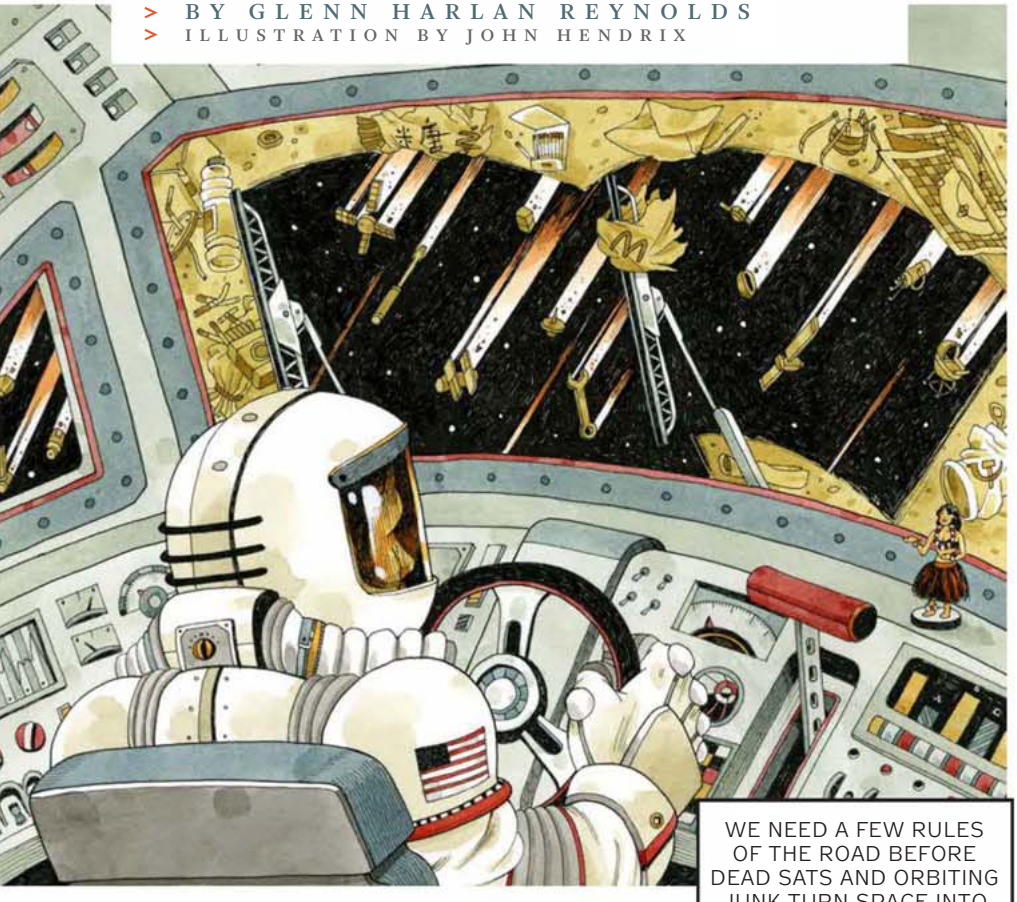


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COLLISION COURSE

> BY GLENN HARLAN REYNOLDS
> ILLUSTRATION BY JOHN HENDRIX



WE NEED A FEW RULES OF THE ROAD BEFORE DEAD SATS AND ORBITING JUNK TURN SPACE INTO A NO-FLY ZONE.

Close calls in orbit happen all the time—scientists estimate that launch vehicles and other objects come within striking distance of one other over 1000 times a day. So when tracking reports on Feb. 10, 2009, predicted that Iridium 33, a 12-foot-long, 1200-pound communications satellite, and a 1-ton Russian military sat, Kosmos 2251, would pass within less than half a mile of each other, no one was alarmed. It wasn't the closest call predicted for that day, or even the closest pass for any of the 66 Iridium satellites that coming week. But at the time of the predicted approach, Iridium 33 fell silent.

The two satellites had collided 500 miles above Siberia at 26,000 mph, generating a debris cloud that spread around the Earth in just a few hours. The junk was in the orbital path of the Hubble Space Telescope and just 250 miles higher than the orbit of the International Space Station.

It was the first time two satellites were known to have collided, which is remarkable considering there are about 3000 of them circling the Earth. And orbiting with the sats are an estimated 16,000 other man-made objects, mostly junk. Depending on the height of orbit—the higher the debris, the longer it takes to decay—fragments may linger in space for centuries.

If enough debris accumulates, we risk setting off a chain reaction called the Kessler syndrome, in which satellite fragments damage other satellites, producing more debris and so on, until low Earth orbit (LEO) is so cluttered that satellite use and space travel become impossible. With LEO getting messier by the day, the February collision raises a thorny legal question: Who is responsible for damages caused by collisions in space?

Contrary to widespread opinion, outer space is not a lawless region. In fact, it's governed by international law—and, in the case of U.S. spacecraft, or the U.S. parts of the International Space Station, by American law. Damage to and by spacecraft is covered by the 1972 Convention on International Liability for Damage Caused by Space Objects. Under that treaty, liability for damage caused to people or property on the ground



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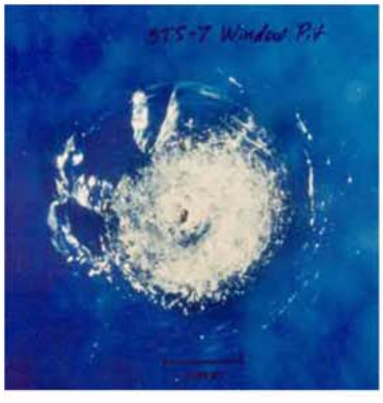
is "absolute"—meaning that the country that launched the spacecraft is liable for damages even if there was no negligence. The same is true if a space object strikes an aircraft. If you operate a spacecraft, you must realize it can do damage wherever it crashes. Expecting people on the ground to be on guard against crashing satellites is asking a bit much.

When it comes to sats in space, however, things aren't so straightforward. When one spacecraft collides with another, there's only liability if the spacecraft operator is negligent. But what constitutes negligence in this context is not clear. Operating a spacecraft in a way that poses a foreseeable risk to others probably qualifies, but in this case the Russian satellite was described as defunct, meaning that it had either broken down or run out of maneuvering fuel. There are many such satellites in orbit, and although good practice calls for their operators to either deorbit them or boost them into harmless parking orbits, this is not always possible. There are no standards in place that require space operators to ensure that satellites don't remain in high-traffic orbits at the end of their lives, so it would be hard to argue that failure to do so constitutes negligence.

One way to prevent space collisions is better traffic control. Right now, satellite operators don't have precise orbital parameters for satellites that might pose a risk of collision. Only a few countries—chiefly the United States, and to some degree Russia and China, as well as Europe—have access to precise tracking data, and that information is kept secret lest it reveal details about the sophisticated instrumentation used to gather it. Military planners have long talked about the need for "space situational awareness," and the military tracks satellites for its own purposes, but the increasingly crowded nature of near-Earth orbits, plus the threat posed by collision debris, has led many to argue that we need similar tracking capability for the civilian sector. The cheap way to do this is to make some of the military data public; the expensive way would be to build a separate civilian system.

Planners in the U.S. and other militaries have good reason to want to keep adversaries guessing about their surveillance capabilities. But they also have good reason not to want to see space filled with debris that is as deadly to their own satellites as it is to civilian craft. The European Space Agency is working on a plan to track 1000 satellites in order to prevent collisions, and all nations that send craft to space should ensure that initial orbits are carefully chosen with an eye toward reduced risk of collision.

IF ENOUGH DEBRIS ACCUMULATES, WE RISK SETTING OFF A CHAIN REACTION—THE KESSLER SYNDROME—THAT WOULD MAKE SPACE TRAVEL IMPOSSIBLE.



A paint chip gouged a crater 0.02 inches deep in the *Challenger*'s windshield. Engineers have replaced shuttle windows after almost every flight since 1981.

But even if these good practices don't come to pass, there's another way to deal with space junk: Clean it up. Specialized spacecraft are designed to rendezvous with intact, nonoperational satellites and take them back to Earth or place them in safer orbits. Cleaning up fragments is much harder. Even small debris traveling at tremendous velocities can wreck a spacecraft, but it's impossible to rendezvous with a paint speck or a lug nut. Some have proposed incinerating debris with lasers, or capturing it with big blobs of orbiting aerogel. But these and other solutions are expensive and may produce more debris from collisions.

Complicating an already complex situation is the fact that debris fragments are often from unidentifiable sources, and who should be responsible for getting rid of the mess is a gray area. Some scholars, including me, have proposed that countries be taxed for debris cleanup based on the amount of material left in orbit, but such proposals remain purely academic.

Unfortunately, current space law doesn't allow for the best possible space-junk solution: salvage. Under the 1967 Outer Space Treaty, nations retain "jurisdiction and control" over their spacecraft even when they are inoperable—so a salvage company wouldn't be able to take title or claim an award for recovering a defunct craft, as is done on Earth. A space salvage law might even help commercial space efforts by providing yet another moneymaking option; governments, or insurance companies, could pay private operators a bounty for eliminating space junk. Though space lawyers have been arguing for years that the proliferation of space junk makes some sort of salvage law necessary, and despite the obvious commercial benefits, there has been little progress.

What's clear is that space is getting crowded, and the problem urgently needs attention from all spacefaring nations, lest we find ourselves earthbound under a shroud of orbiting trash. **PM**

Glenn Harlan Reynolds, a PM contributing editor, teaches space law at the University of Tennessee.

Bipolar Disorder can affect your job, family, and friends.



You can spend years managing the extreme ups and downs, the mood swings and relapses, trying to control your manic symptoms.

Maybe ABILIFY can help

ABILIFY helps control the symptoms of bipolar mania and reduce the risk of manic relapse. It is used for short-term and maintenance treatment of manic or mixed episodes in adults with Bipolar I Disorder.

ABILIFY was shown to have a low risk of significant weight gain in 3-week clinical trials in adults.*

Hundreds of thousands of adults have been prescribed ABILIFY. ABILIFY is one of many treatment options.

Ask your healthcare professional if once-a-day ABILIFY is right for you.

Individual results may vary.
***Significant weight gain in adults: ABILIFY 2%, sugar pill 3%.**

IMPORTANT SAFETY INFORMATION:

Elderly patients with dementia-related psychosis (eg, an inability to perform daily activities due to increased memory loss) taking ABILIFY have an increased risk of death or stroke. ABILIFY is not approved for treating these patients.

Some medicines can increase suicidal thoughts and behaviors in children, teens, and young adults. Serious mental illnesses are themselves associated with an increase in the risk of suicide. When taking ABILIFY call your doctor right away if you have new or worsening mood symptoms, unusual changes in behavior, or thoughts of suicide. Patients and their caregivers should be especially observant within the first few months of treatment or after a change in dose.

- Alert your doctor if you develop very high fever, rigid muscles, shaking, confusion, sweating, or increased heart rate and blood pressure, as these may be signs of a rare but potentially fatal condition called neuroleptic malignant syndrome (NMS)
- If you develop abnormal or uncontrollable facial movements, notify your doctor, as these may be signs of tardive dyskinesia (TD), which could become permanent
- If you have diabetes or have risk factors or symptoms of diabetes, your blood sugar should be monitored. High blood sugar has been reported with ABILIFY and medicines like it. In some cases, extreme high blood sugar can lead to coma or death
- Other risks may include lightheadedness upon standing, seizures, trouble swallowing, or impairment in judgment or motor skills. Until you know how ABILIFY affects you, you should not drive or operate machinery

The common side effects in adults in clinical trials (≥10%) include nausea, vomiting, constipation, headache, dizziness, an inner sense of restlessness or need to move (akathisia), anxiety and insomnia. Tell your doctor about all the medicines you're taking, since there are some risks for drug interactions. You should avoid alcohol while taking ABILIFY.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

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IMPORTANT INFORMATION ABOUT ABILIFY

This summary of the Package Insert contains risk and safety information for patients about ABILIFY. This summary does not include all information about ABILIFY and does not take the place of discussions with your healthcare professional about your treatment. Please read this important information before you start taking ABILIFY and discuss any questions about ABILIFY with your healthcare professional.

Name

ABILIFY® (a-BIL-i-fi) (aripiprazole) (air-i-PIP-ra-zall)

What is ABILIFY?

ABILIFY (aripiprazole) is a prescription medicine used for treatment of adult patients with manic or mixed episodes associated with Bipolar I Disorder.

What is Bipolar I Disorder?

Bipolar I Disorder is an illness with symptoms thought to be caused by an imbalance of brain chemicals. People who have Bipolar I Disorder tend to experience extreme mood swings, along with other specific symptoms and behaviors. These mood swings, or "episodes," can take three forms: manic, depressive, or mixed episodes. Common symptoms of a manic episode are: feeling extremely happy, being very irritable and anxious, talking too fast and too much, and having more energy and needing less sleep than usual. Common symptoms of a depressive episode include: feelings of overwhelming sadness or emptiness, low energy, a loss of interest in things, trouble concentrating, changes in sleep or appetite, and thoughts of dying or suicide. A mixed episode includes symptoms that are both manic and depressive.

Who should NOT take ABILIFY?

People who are allergic to ABILIFY or to any substance that is in it. Allergic reactions have ranged from rash, hives and itching to difficulty breathing and swelling of the face, lips, or tongue. Please talk with your healthcare professional.

What is the most important information that I should know about ABILIFY?

Elderly patients, diagnosed with psychosis as a result of dementia (for example, an inability to perform daily activities as a result of increased memory loss), and who are treated with antipsychotic medicines including ABILIFY, are at an increased risk of death when compared to patients who are treated with a placebo (sugar pill). ABILIFY is not approved for the treatment of patients with dementia-related psychosis.

Some medicines can increase suicidal thoughts and behaviors in children, teens, and young adults. Serious mental illnesses are themselves associated with an increase in the risk of suicide. When taking ABILIFY call your doctor right away if you have new or worsening mood symptoms, unusual changes in behavior, or thoughts of suicide. Patients and their caregivers should be especially observant within the first few months of treatment or after a change in dose.

Serious side effects can occur with any antipsychotic medicine, including ABILIFY. Tell your healthcare professional right away if you have any conditions or side effects, including the following:

Stroke or ministroke in elderly patients with dementia: An increased risk of stroke and ministroke has been reported in clinical studies of elderly patients with dementia (for example, increased memory loss and inability to perform daily activities). ABILIFY is not approved for treating patients with dementia.

Neuroleptic malignant syndrome (NMS): Very high fever, rigid muscles, shaking, confusion, sweating, or increased heart rate and blood pressure **may be signs of NMS, a rare but serious side effect that could be fatal.**

Tardive dyskinesia (TD): Abnormal or uncontrollable movements of face, tongue, or other parts of body may be signs of a serious condition known as TD, which may be permanent.

High blood sugar and diabetes: Patients with diabetes and those having risk factors for diabetes (for example, obesity, family history of diabetes), as well as those with symptoms such as unexpected increases in thirst, urination, or hunger should have their blood sugar levels checked before and during treatment. Increases in blood sugar levels (hyperglycemia), in some cases serious and associated with coma or death, have been reported in patients taking ABILIFY, and medicines like it.

Orthostatic hypotension: Lightheadedness or faintness caused by a sudden change in heart rate and blood pressure when rising too quickly from a sitting or lying position (orthostatic hypotension) has been reported with ABILIFY.

Suicidal thoughts: If you have suicidal thoughts, you should tell your healthcare professional right away.

Dysphagia: Medicines like ABILIFY have been associated with swallowing problems (dysphagia). If you had or have swallowing problems, you should tell your healthcare professional.

What should I talk to my healthcare provider about?

Patients and their families or caregivers should watch for new or worsening mood symptoms, unusual changes in behavior and thoughts of suicide, as well as for anxiety, agitation, panic attacks, difficulty sleeping, irritability, hostility, aggressiveness, impulsivity, restlessness, or extreme hyperactivity. Call your healthcare provider right away if you have thoughts of suicide or if any of these symptoms are severe or occur suddenly. Be especially observant within the first few months of antidepressant treatment or whenever there is a change in dose.

Tell your healthcare provider:

- About any medical conditions you may have
- Whether you're taking any other prescription or nonprescription (over-the-counter) medicines
- Whether you're pregnant, plan to become pregnant, or are breast-feeding
- If you or anyone in your family has had seizures
- If you or anyone in your family has had high blood sugar or diabetes

What should I avoid when taking ABILIFY (aripiprazole)?

- Avoid overheating and dehydration
- Avoid driving or operating hazardous machinery until you know how ABILIFY affects you
- Avoid drinking alcohol
- Avoid breast-feeding an infant

What are the possible side effects of ABILIFY?

Common side effects in adults include: nausea, vomiting, constipation, headache, dizziness, an inner sense of restlessness or need to move (akathisia), anxiety and insomnia.

It is important to contact your healthcare professional if you experience prolonged, abnormal muscle spasm or contraction which may be signs of a condition called dystonia.

What percentage of people stopped taking ABILIFY due to side effects?

In clinical trials, the percentage of adults who discontinued taking ABILIFY due to side effects was ABILIFY (11%) and for patients treated with sugar pill (9%).

Can I safely take ABILIFY while I'm taking other medications?

ABILIFY can be taken with most drugs; however, taking ABILIFY with some medicines may require your healthcare professional to adjust the dosage of ABILIFY.

Some medicines* include:

- ketoconazole (NIZORAL®)
- quinidine (QUINIDEX®)
- fluoxetine (PROZAC®)
- paroxetine (PAXIL®)
- carbamazepine (TEGRETOL®)

It is important to tell your healthcare professional about all the medicines you're taking, just to be sure.

General advice about ABILIFY:

- ABILIFY is usually taken once a day, with or without food
- ABILIFY should be kept out of the reach of children and pets
- Store ABILIFY Tablets and the Oral Solution at room temperature
- For patients who must limit their sugar intake, be aware that **ABILIFY Oral Solution contains sugar**
- For patients who cannot metabolize phenylalanine (those with phenylketonuria or PKU), **ABILIFY DISCMELT® contains phenylalanine**
- If you have additional questions, talk to your healthcare professional

Find out more about ABILIFY:

Additional information can be found at **www.abilify.com/bipolardisorder**

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THE GOODS

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Ring of Fire
The Alaska Volcano Observatory monitors 160 volcanoes that lie beneath one of the world's busiest air traffic corridors (selected flight paths shown above). The 10 volcanoes above last erupted within the decade, during the years indicated.

VOLCANO WATCHERS

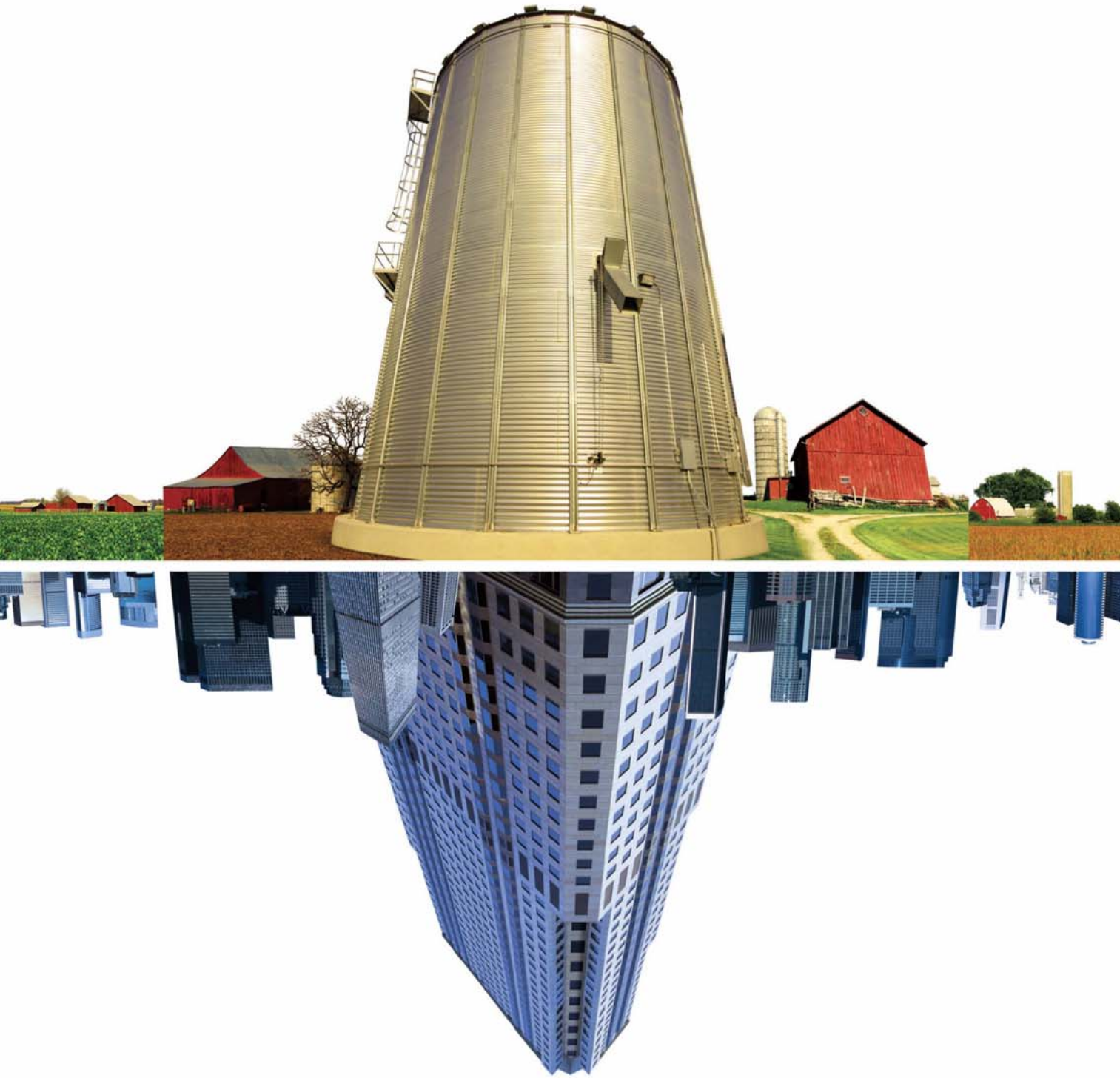
> BY DOUGLAS FOX
> ILLUSTRATION BY 64 COLORS

EACH YEAR, 73,000 FLIGHTS PASS ABOVE ONE OF THE MOST VIOLENT VOLCANIC ARCS ON EARTH.

When seismographs on Great Sitkin Island, in the Aleutian Island chain between Alaska and Russia, detected slight tremors in August 2008, Kasatochi—the small, tranquil volcano sitting 26 miles away—seemed an unlikely source. After all, it wasn't a troublemaker; in fact, some scientists believed it was extinct. Its crater, cupping a peaceful lake, hadn't erupted in more than a century.

But for Jonathan Dehn, a 47-year-old volcanologist at the Alaska Volcano Observatory (AVO) in Fairbanks, the rumblings were sufficient cause for alarm. Though Kasatochi sits 1100 miles out on the Aleutian arc, far from major cities, it lurks below one of the busiest air traffic corridors on Earth.

On Aug. 7, as Dehn and his colleagues crowded into the AVO operations room to discuss the tremors—some argued they were indicative of normal tectonic grinding, not of volcanic activity—any deliberation suddenly became moot. An image from the Geostationary Operational Environmental Satellites (GOES) flashed onto one of the room's dozen computer monitors. The satellite showed



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a blip of white over Kasatochi—distinct from the gray storm clouds blanketing the Aleutians—indicating that the volcano had just vomited millions of cubic feet of ash. Hurricane-force convective currents were lifting the ash at 1 to 2 miles per minute, 45,000 feet into the sky.

Another monitor showed as many as a dozen planes headed toward the area; some were due to arrive within minutes. If they encountered the plume, it could mean disaster: The fine-grained pumice in volcanic ash can stall a jet engine within 60 seconds. Planes don't carry instruments that can detect ash, and by the time a pilot spots an ash cloud, it's too late—jets travel 9 miles per minute.

Staff at AVO offices in Fairbanks and Anchorage rushed calls to the Federal Aviation Administration, the Alaska Division of Homeland Security and Emergency Management and a dozen other agencies. Alerts reached pilots within minutes, enabling them to change course.

Scientists tracked Kasatochi's plume—a mixture of ash and 1.5 million tons of sulfur dioxide gas—via satellite over several days. It drifted toward Juneau, Alaska, where airlines cancelled more than 40 flights. Farther west, a 737 carrying passengers over Canada lost cabin pressure twice after flying through dilute ash. The jet stream stretched the volcanic cloud into a shadow that curved across North America. Pilots as far east as Chicago adjusted their routes to avoid it. The cloud contained sulfuric acid aerosols capable of etching plane windows, corroding paint and nauseating passengers.

AVO's system worked well. But for Dehn, it was a reminder of the need to watch volcanoes—every volcano—at all times. "Kasatochi was a surprise," he says. "We were very lucky."

International flights crossing the ocean into Anchorage airspace have swelled by 83 percent since 1990, to 73,000 flights per year—making Anchorage the world's fifth-busiest air-cargo hub. But few people flying from Asia to North America realize their trip takes them over one of the most violent volcanic arcs on Earth.

Subduction of the Aleutian plate forces more than 20 million tons of rock under the island chain daily, fueling an arc of 160 volcanoes that stretches from Alaska, across the Aleutians, to the Kamchatka Peninsula of Russia. As the rock melts into viscous, silica-rich magma, it traps thousands of tons of water. When the magma reaches the surface, the water becomes steam and bursts like bubbles from a soda can, making the volcanoes especially explosive.

"Twenty-five thousand people and a billion dollars of cargo fly over these volcanoes every single day," Dehn says. "It's been described as a shooting gallery." AVO's mission is to monitor volcanic activity, track ash clouds and give ample warning to air traffic. The need for such vigilance became clear after what could have been one of the worst air disasters in history.







When Redoubt Volcano erupted on Dec. 15, 1989, KLM Flight 867 was en route to Anchorage from Amsterdam with 245 people on board. As the 747 descended through a cloud, nearly 200 miles from the eruption, sulfur and smoke stung the pilots' nostrils. Then all four engines failed. The turbines had ingested abrasive ash—tiny shards of volcanic glass melted in the engines and resolidified into lumps, choking the air supply. "We have flameout, all engines," co-pilot Imme Visscher barked into the radio. "We are in a fall!"

After the plane dropped 13,000 feet, Visscher managed to restart two engines, then the other two. She and her crew flew the crippled craft over the peaks of the Alaska mountain range to Anchorage, squinting to see through windows blasted by microscopic pumice.

The KLM incident was not the first close call—or the last. "There have been more than 100 encounters of aircraft with ash clouds since the early 1970s," says Marianne Guffanti, a volcanologist at the U.S. Geological Survey in Reston, Va. The first known incident involved a civilian C-130 that temporarily lost power to two of four engines when Mount St. Helens erupted in 1980. At least eight planes have experienced similar mechanical



Gathering Data
← AVO field tech Max Kaufman installs GPS at Dumbbell Hills to monitor ground deformation caused by plate tectonics and volcanic activity.

↙ Jonathan Dehn in AVO's control room.

↙↙ Scientists use sensors to measure lightning in Redoubt's eruptive plume; the volcano was still active at press time.

problems since, including two commercial aircraft over the Philippines in 1991 and a research jet over Papua New Guinea in 2006. But the KLM incident highlighted just how dramatic and close to home the threat could be. Prior to that event, AVO—then only a year old—used its budget to place a few monitoring instruments near Cook Inlet; when the Observatory got full funding in the mid-'90s, scientists decided to fully instrument Redoubt first.

Of the 160 volcanoes the Alaska Volcano Observatory monitors, 60 have the potential to erupt at any time—and only 30 of those volcanoes have seismic networks. Seismographs can pick up tremors signaling a potential eruption days in advance, allowing scientists to watch the volcanoes closely and alert nearby pilots within 5 minutes of the actual eruption—the FAA's official goal.

To monitor the other volcanoes, AVO relies on satellite observation. National Oceanic and Atmospheric Administration satellites carry the Advanced Very High Resolution Radiometer, an imager that can detect infrared "thermal anomalies" as a volcano's belly swells with 1500 F magma. The ozone-monitoring Aura satellite can track clouds of sulfur dioxide burped out by volcanoes. And satellites like GOES and POES, or Polar Operational Environmental Satellites, can spot new ash clouds.

But relying on satellites involves an element of Russian roulette. Satellite passes over any given area may occur up to 5 hours apart—long enough for a crowded 747 to fly directly into a new ash plume. Clouds can obstruct satellites' views; some Aleutian volcanoes are under cover 300 days a year. "You may not see an area for many days in a row," says Gary Hufford, a remote-sensing specialist at the National Weather Service in Anchorage. "All of a sudden it opens up and you see hotspots."

When Redoubt, 103 miles southwest of Anchorage, rumbled back to life in early 2009, researchers seized the opportunity to experiment with new technologies. Steve McNutt, a volcano seismologist at AVO in Fairbanks, placed four VHF radio-wave sensors across the Cook Inlet from Redoubt, 50 miles away. Heavy lightning occurs inside eruptive plumes, generated by static electricity as ash particles collide inside the cloud. The sensors measure the radio waves produced by each strike.

Redoubt erupted on March 22, coughing ash 60,000 feet into the air. McNutt's instruments detected the eruption nearly instantly—picking up lightning that began as soon as ash started spewing from the crater. Nanosecond triangulation of the radio bursts pinpointed lightning bolts to an accuracy of 164 feet, allowing McNutt to track the cloud for an hour as it drifted north.

By measuring how bolts move through the plume, McNutt can determine how much ash comes out—information that's crucial to forecasting how quickly ash will settle and dilute as it drifts. A network of sensors like the one tested on Redoubt could alert AVO to eruptions at remote volcanoes, providing a backup to satellites. Because they don't have to be as close to the source as seismometers, two dozen lightning sensors could monitor the entire Aleutian chain.

Meanwhile, a team that includes Fred Prata, a senior scientist at the Norwegian Institute for Air Research, in Kjeller, Norway, has built a prototype detector that distinguishes ash from water clouds based on infrared absorbance. Prata's goal is to layer that information onto weather displays in the cockpit; ash clouds would be red and other clouds, blue. The detector could be effective 62 miles ahead at cruising altitudes.

None of these technologies is foolproof. And though the stimulus plan just increased AVO funding, Dehn says they don't plan to spend the money instrumenting every volcano. Instead, they hope to upgrade existing seismographs to broadband capability, which will help scientists get information more quickly—and will minimize the chance that an ash plume escapes detection and brings down an aircraft. **PM**



25 BIG IDEAS

THE WORLD FACES TOUGH CHALLENGES—AND PM IS ON THE JOB. TO FIND SOLUTIONS TO EVERYTHING FROM DROUGHT TO TRAFFIC SNARLS, WE CALLED SOME OF AMERICA'S SMARTEST ENGINEERS AND SCIENTISTS FOR A MIX OF QUICK FIXES AND LONG-TERM PROPOSALS. (AND, YES, ROBOTS WERE DISCUSSED.) *HERE'S THE PM ACTION PLAN.*

BY ERIK SOFGE PHOTOGRAPH BY JAMIE CHUNG



TURN TRASH INTO POWER

The Green Energy Machine, or GEM, is an unlikely alt-fuel hero. Yet the dumpster-size cargo container jutting from a building in Waltham, Mass., can heat and power 200,000 square feet of space on a daily diet of 3 tons of garbage. The $850,000 system, which incorporates a Rube Goldberg–like array of devices, can pay for itself in three years, according to Michael Cushman, vice president of IST Energy, which makes GEMs. It can save some 540 tons of greenhouse gas emissions annually and—unlike much alt-energy tech—it's ready now. "We welcome revolutionary technology, but this is an evolutionary solution with substantial potential for high impact," Cushman says. "We don't need a 10-year-off solution, we need a today solution."

BUILD START–STOP INTO EVERY VEHICLE

By 2012, manufacturing giant Bosch estimates, half the new vehicles in Europe will be able to shut down their engines whenever they begin to idle. Hybrids already work this way. Bosch says its own system, Smart Starter, can boost a conventional car's city-driving fuel economy by 8 percent. Carmakers won't say how much such technology will raise prices, but the bump should be a fraction of the premium that hybrid systems demand. The technology isn't scheduled for introduction in the United States. It should be.

CONJURE FUEL FROM CO_2

Nanotube arrays can increase the surface area of a catalyst, and thus are one of the many "next big things" in

PORTRAITS BY MIKE McGREGOR

HAND-BLOWN GLASS BY ERIC MEEK

energy research, especially for batteries. But Craig Grimes, an electrical engineer at Penn State, has another use for them. In combination with sunlight, his nanotube membrane converts water and carbon dioxide into liquid fuel, such as butane and methane. If the technology were integrated into power plants, Grimes says, "it would basically be a closed loop—you have a fuel, you burn it, you collect the reactants, convert them back into fuel, and then feed that right back into the plant." He calculates that 4 square inches of the current version of the membrane could yield more than 130 gallons of fuel daily, squeezing a second act out of hydrocarbons before they enter the atmosphere.

FIX CRUMBLING PIPES WITH SINUOUS ROBOTS

Oil companies employ drones called "pigs" to crawl through pipelines, spotting corrosion. Fancier pipe bots are in development, destined for heroic feats such as shimmying through shattered plumbing to find earthquake survivors. But the most useful job for such robots could be patrolling thousands of miles of leaking municipal water lines. One design group took the inspiration for its bloblike robot from amoebas, but most of the new bots resemble snakes. A Canadian robot called Regina Pipe Crawler (RPC) is nearing commercialization. Controlled remotely, RPC can inspect a bending 6-inch-diameter pipe while the water is flowing at full strength. With enough pipe bots on the job, engineers could stop wasteful leaks and prevent catastrophic failures.

DRIVE ON A HIGH LEVEL

Road congestion gets worse every year, yet thousands of miles of highway—the medians, to be precise—go unused. According to bridge engineer Linda Figg, a gap just 6 feet across can support an elevated roadway three lanes wide. Figg's Lee Roy Selmon Crosstown Expressway added three reversible lanes to a 15-mile stretch of median between Brandon, Fla., and downtown Tampa, cutting travel time from 45 minutes to as little as 20. Such bridges can also carry light rail—Figg's AirTrain JFK project carries travelers above New York City's Van Wyck Expressway to Kennedy Airport. The projects require little new grading and no seizures of property. "Look at data networks, the way they've been optimized," Figg says. "They have higher speeds, they're more efficient, but we're using the same networks. This is the same—we're optimizing our corridors by building at multiple levels."

Use NASA Tech to Build Better Airliners

The story of winged human flight begins without a tail—the Wright Brothers' first successful glider didn't have one. Soon, biplanes ushered in the now-standard tube-and-wing design for aircraft, but experiments with blended wings never really stopped. The planes are potentially more aerodynamic and consume less fuel, though they are harder to maneuver. Researchers hope that computerized, fly-by-wire systems will soon overcome the control challenges and spawn an era of fuel-efficient heavy lifters. One proposed design is the SAX-40, an airliner that could trim fuel use by more than 20 percent and fly quietly enough to take off and land during late-night hours that are currently restricted. According to Jim Hileman, a researcher at MIT and chief engineer on the project, expanding the hours of operation for airports could



CALL IN THE STAR TREK WRITERS

Cloak Buildings From Earthquakes

Like so many of the best things in life, the inspiration for cloaking technology comes from the Klingons, who used it on their starships. Researchers have had some success "cloaking" an object by redirecting light around it to render it invisible. But the principle might work even better to shield buildings from earthquake damage. The structures would incorporate "metamaterials" patterned with tiny circles whose size is proportional to the wavelength of seismic disturbances. The waves would travel along the material, missing the structure. ***REAL-WORLD POTENTIAL:*** *The theory*

ENVIRONMENT ILLUSTRATION BY DOGO



ILLUSTRATION BY **AXEL PFAENDER**

reduce air traffic congestion—and the fuel wasted by circling planes—while avoiding legal battles over new runway construction. The plane is just a thought experiment for now, created by Hileman and his colleagues in the Silent Aircraft Initiative, a U.K.-funded collaboration between Cambridge University and MIT. But the design's enthusiasts are encouraged by successful, ongoing tests of the X-48B, a blended-wing prototype built by Boeing in cooperation with NASA and the Air Force. The company is focusing purely on military applications, but Hileman points out that wrestling civilian benefits from defense research is a grand old aviation tradition—the 707, Boeing's first commercial passenger jet, had a military lineage. "Maybe the U.S. Air Force will build a better tanker or bomber, which leads to a blended-wing airliner." Ultimately, Hileman says, aeronautical engineers will have to step up their game. "We haven't reached full maturity with our designs," he says. "We can still make a real impact on fuel use and aircraft noise."



LIMITED WINDOWS ***Researchers debate how many passengers a blended wing would carry. A proposed 600-person jet would require seats at the edge of the wings and could make a minor bank feel like a barrel roll. The SAX-40 is designed for a head count of 215. Either way, the reduced window-to-passenger ratio would make in-flight entertainment systems a priority.***

EFFICIENT FLYING ***Without a tail or tube to break up airflow, a wedge-shaped blended-wing airliner would create little drag.***

QUIETER ENGINES ***The embedded engines proposed for the SAX-40 would allow for reduced engine noise (thanks to rear-mounted mufflerlike attachments) with no sacrifice in thrust.***

seems sound, but years of experimentation lie ahead. And engineers would then need to devise ways to build the technology into new buildings. (Retrofits would likely remain impossible.)

Teleport Data in Super Computers

Star Trek–style teleporters will never, ever be invented. And that's okay—after all, who would agree to be obliterated and then reconstituted by a guy named Scotty, trusting that no atom or eyeball was out of place? But scientists at the University of Maryland have teleported data, swapping the quantum states of two atoms positioned a meter apart. It was a step toward the creation of quantum computers, which could perform many simultaneous operations, crunching data exponentially faster than today's systems. ***REAL-WORLD POTENTIAL:*** *On a rudimentary level, the technology works now, but practical (let alone world-changing) quantum computing is decades in the future.*

Mind-Meld With Machines

Who needs a joystick when that famously complex CPU between your ears can exert direct control over a machine? Miguel Nicolelis, co-director of Duke University's Center for Neuroengineering, has shown that monkeys can make robots walk simply by thinking. Next, he is focusing on sensory feedback. Sure, touch and vision would be nice, but Nicolelis hopes that human brains eventually can learn to interpret data from such diverse sources as magnetic sensors and infrared imaging systems, essentially developing new, machine-based senses. (Hey, the Borg can do it.)

REAL-WORLD POTENTIAL: *Within five years, Nicolelis plans to introduce a brain-controlled, full-body exoskeleton to restore mobility to severely disabled patients. Potential applications are wide-ranging—imagine surgeries being performed by a specialist from across the country. There's an issue with user-friendliness, though—little of this cybernetic wizardry will come to pass until someone invents an interface that doesn't require a cable to be implanted in the user's brain.*

IF PM RAN THE WORLD



PLANE ILLUSTRATION BY **JEREMY COOK**



HURL ROCKS AT GLOBAL WARMING

STRATEGY
Carbon sequestration with a twist of limestone

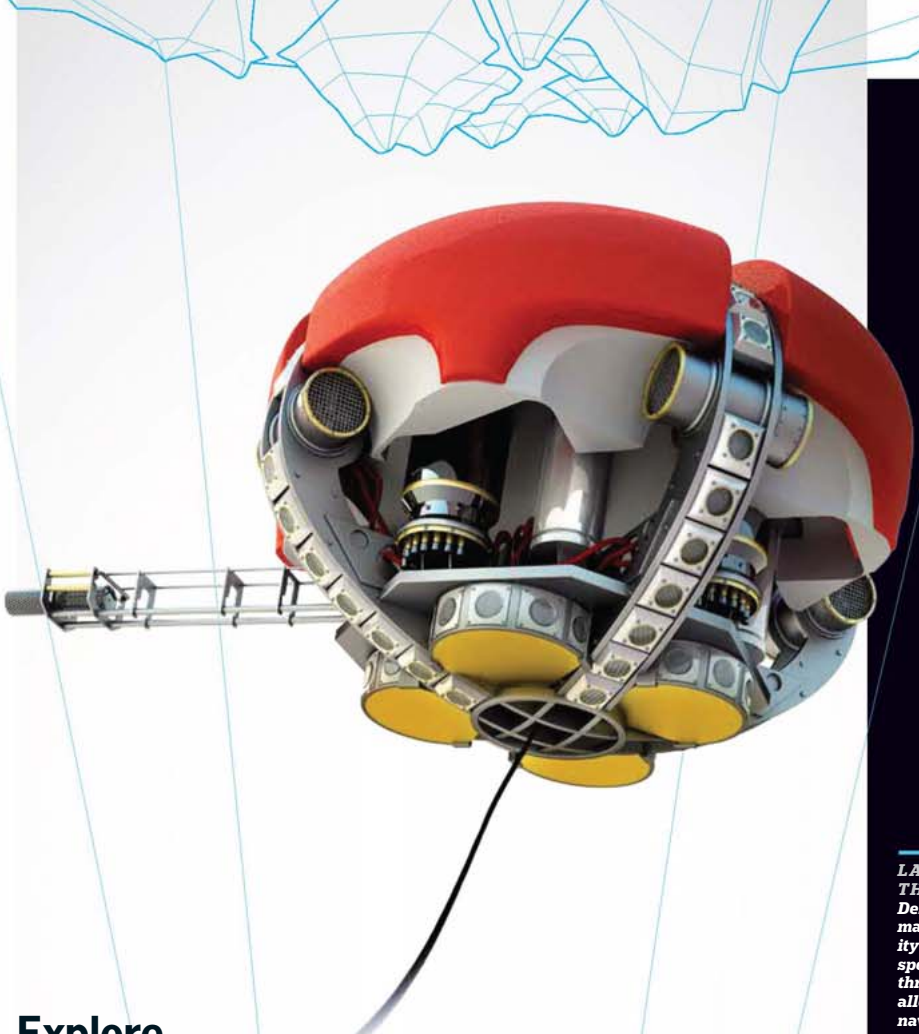
REAL-WORLD LAB
Rock formations in Oman

PROPONENT
Peter Kelemen, geologist

More than a decade ago, when geologist Peter Kelemen first saw bleached-white rock formations in Oman, he wasn't happy. The normally dark-hued rocks were peridotite whose composition he was trying to investigate. But every time Kelemen found an exposed surface, it had reacted with carbon dioxide in the air to form a carbonate similar to limestone. Goodbye, samples. "I ran in the other direction as fast as I could," he says. That outlook changed in 2004, when Kelemen had a eureka moment while talking with colleagues at Columbia University's Lamont-Doherty Earth Observatory about ways to sequester CO_2 underground and slow the pace of global warming. Most sequestration plans risk creating a carbon-dioxide time bomb, with the greenhouse gas stored underground and always threatening to bubble out. Kelemen thought the peridotite might provide a longer-lasting solution. His idea is to drill into massive rock formations, heat them and then pump in CO_2-enriched water. The rock would then turn to carbonate, trapping the gas in enduring, solid form. Kelemen stresses that the real-world practicality of his plan still needs to be proven. But field observations in Oman, which has more than 3000 cubic miles of peridotite, have been promising. Next up: investigating the idea in the United States.

Geologist Peter Kelemen, photographed for Popular Mechanics on April 1, 2009, holding a chunk of peridotite, a rock that could hold the key to mineral carbon sequestration.

ENVIRONMENT ILLUSTRATION BY DOGO



Explore Alien Seas—on Earth

While hostile, distant Mars is crisscrossed by intrepid rovers and captured in loving detail by orbiting unmanned fliers, some 95 percent of Earth's oceans remain uncharted. If that's not enough of a snub, the autonomous underwater vehicle (AUV) most adept at studying ice-covered Antarctic waters, NASA's ENDURANCE (short for Environmentally Non-Disturbing Under-ice Robotic Antarctic Explorer), is using our waters as a mere stepping stone for larger ambitions. The nimble robot is being readied for a mission to Europa, a Jovian moon that could, just maybe, harbor rich biodiversity beneath its frozen seas. Peter Doran, a professor of earth sciences at the University of Illinois and principle investigator for ENDURANCE, wants to reassign the robot to ongoing Earth duty. He also proposes developing additional homebound AUVs, including a miniature version of ENDURANCE (which is the size of a small car) that would be easier to operate and deploy, and a "regional cruiser," a much larger nuclear-powered robot able to map the entire Ross Ice Shelf without refueling. (Arguably, you'd need ice water in your veins to send a self-guided, reactor-bearing vehicle under unstable ice sheets.) In addition to studying extremophiles and other organisms, particularly in the polar regions, Doran says the robots could take water samples, tracking changes in salinity and acidity caused by climate change. "A satellite only gets you so much," he says. "The penetration is on the order of centimeters. Getting under the ocean isn't something we do very well."

LATERAL THRUSTERS
Designed for maneuverability rather than speed, enclosed thrusters allow for precise navigation, and can help brace the robot against shifting currents.

OBSTACLE-AVOIDANCE SONAR ARRAYS
Short-range sonar pings from arrays on all sides of the drone prevent collisions with underwater ice formations.

ONBOARD SENSORS
The probe could use a combination of inline sensors, which analyze water passing through tubes in the vehicle, and instruments mounted on cables or articulated arms.

IF PM RAN THE WORLD

ILLUSTRATION BY **TRANSLUSZENT**



BREED SUPER-RICE TO FEED THE WORLD

STRATEGY
Use genetic engineering to breed hardier crops—but avoid the backlash

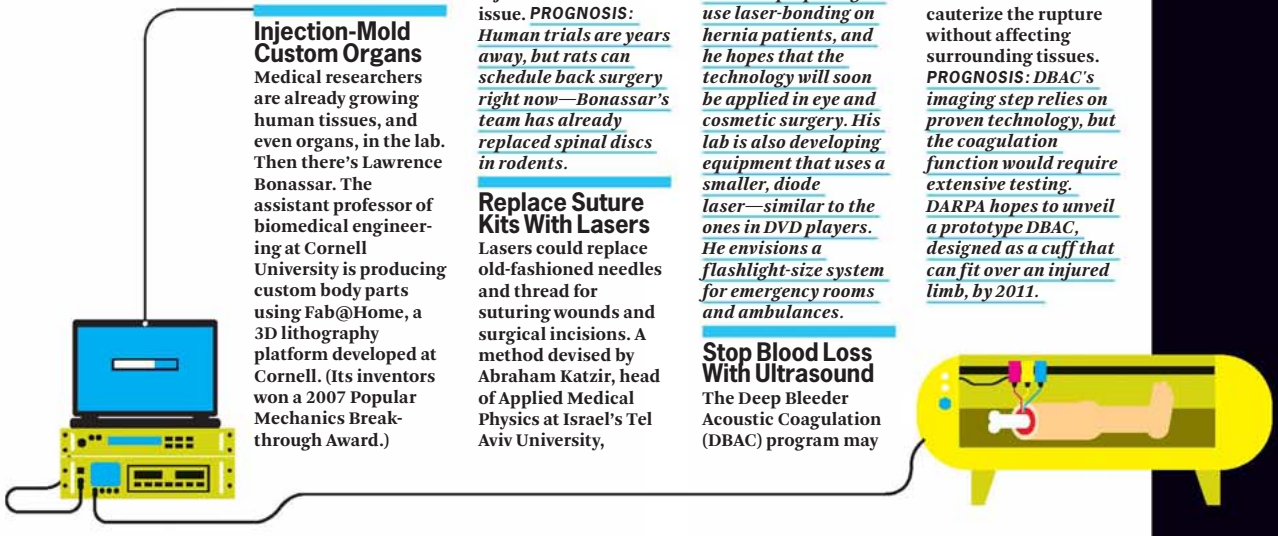
REAL-WORLD LAB
Flooded paddies in Bangladesh

PROPONENT
Pamela Ronald, genetic engineer

Pamela Ronald is a genetic engineer with little patience for debates over "frankenfoods." If swapping some DNA base pairs around will fight hunger, she's all for it. Besides, she says, people have been meddling with genes for more than 10,000 years. "Everything on your table, everything you eat, has been genetically improved," Ronald says. "With the exception, maybe, of some wild blueberries, none of it occurs in nature." Nevertheless, Ronald finds herself sidestepping the genetic modification controversy by helping develop the new field of "precision breeding." Her lab at the University of California–Davis isolated a gene that imparts impressive flood tolerance to a rice variety found in eastern India. A collaborator then incorporated that Sub1 gene into a strain valued by Indian and Bangladeshi farmers. The new crops retained their best characteristics—but now the rice could survive for two weeks underwater, while conventional plants would have died within days. Since all the genetic material came from the same species, few observers—even in purity-obsessed Europe—can raise objections. Researchers now plan to develop rice strains that need less moisture and fertilizer, can fight off destructive microbes and can thrive in saltier conditions. Roughly half of the world's population relies on rice, so the development of more resilient strains can aid hundreds of millions around the globe. And that's just the beginning. "Rice is like the fruit fly of cereal studies," Ronald says. "What we discover in rice, we can apply to wheat and maize."

Genetic engineer Pamela Ronald, photographed for Popular Mechanics on April 14, 2009. The flood-tolerant rice she helped develop has been grown successfully in Bangladesh.

EMBRACE MEDICINE'S MACHINE AGE



Injection-Mold Custom Organs

Medical researchers are already growing human tissues, and even organs, in the lab. Then there's Lawrence Bonassar. The assistant professor of biomedical engineering at Cornell University is producing custom body parts using Fab@Home, a 3D lithography platform developed at Cornell. (Its inventors won a 2007 Popular Mechanics Breakthrough Award.) Bonassar's "ink" is a culture of living cells suspended in gel. For homogeneous organs, he can skip the printer, squirting biogel right into an injection mold. And since the cells originate with the patient, organ rejection is not an issue. ***PROGNOSIS:*** *Human trials are years away, but rats can schedule back surgery right now—Bonassar's team has already replaced spinal discs in rodents.*

Replace Suture Kits With Lasers

Lasers could replace old-fashioned needles and thread for suturing wounds and surgical incisions. A method devised by Abraham Katzir, head of Applied Medical Physics at Israel's Tel Aviv University, involves slathering the target area with a protein, then tracing the wound with a carbon-dioxide laser. According to Katzir, the procedure reduces surgical scars, healing time and the chance of infection. ***PROGNOSIS:*** *Katzir is preparing to use laser-bonding on hernia patients, and he hopes that the technology will soon be applied in eye and cosmetic surgery. His lab is also developing equipment that uses a smaller, diode laser—similar to the ones in DVD players. He envisions a flashlight-size system for emergency rooms and ambulances.*

Stop Blood Loss With Ultrasound

The Deep Bleeder Acoustic Coagulation (DBAC) program may sound like tech from some cyberpunk novel, but it's real engineering being developed with funding from DARPA, the Pentagon's research wing. DBAC will locate severed arteries deep below the skin, then use ultrasonic waves to cauterize the rupture without affecting surrounding tissues. ***PROGNOSIS:*** *DBAC's imaging step relies on proven technology, but the coagulation function would require extensive testing. DARPA hopes to unveil a prototype DBAC, designed as a cuff that can fit over an injured limb, by 2011.*

USE FUSION TO ZAP NUCLEAR WASTE

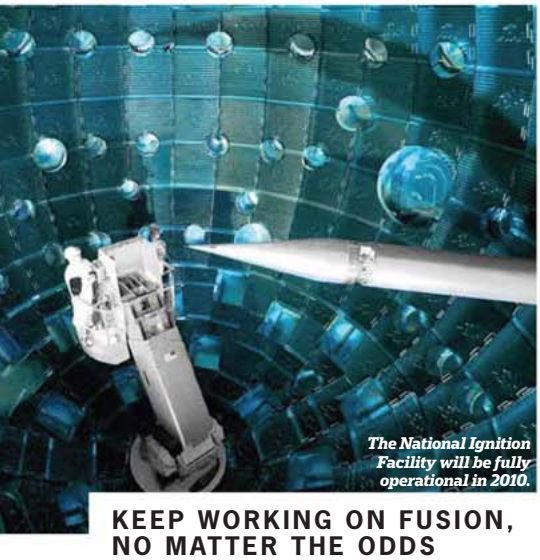
The quest for controlled fusion power, that most future-topian of engineering feats, requires patience and enduring faith. Progress is being made (see "Keep Working on Fusion," page 68), but workable reactors are decades off. While we wait, fusion may as well make itself useful. Researchers at the University of Texas recently unveiled a design for a hybrid fission–fusion reactor, a best-of-both-worlds device that would dispose of the deadliest waste from traditional nuclear power plants while generating power along the way. Most nuclear waste can be reprocessed for use as fuel in standard fission reactors, although that's not currently the practice in the United States. The hybrid reactor would be a next step. It would employ fusion reactions to flood the remaining, highly dangerous transuranic waste with neutrons, allowing it to be burned in a fission process. One-third of the resulting energy would be fed back into the fusion process and the remaining 700 megawatts would be fed into the grid. According to senior research scientist Swadesh Mahajan, at the end of the process, about 99 percent of all nuclear waste could be eliminated. "What we really want to do is to tell the world, Please allow the expansion of nuclear energy, through standard light-water reactors," Mahajan says. "It's the only thing that can be ramped up quickly enough to replace coal. Do not worry about the waste. Because we're going to give you the solution in 20 years. We will make it in time."



A new hybrid fission–fusion reactor design was developed by this University of Texas team: Erich Schneider of the mechanical engineering department (second from right) and (from left) Michael Kotschenreuther, Swadesh Mahajan and Prashant Valanju, all from the school's Institute for Fusion Studies.

SCI-FI ILLUSTRATION BY AXEL PFAENDER

IF PM RAN THE WORLD



The National Ignition Facility will be fully operational in 2010.

KEEP WORKING ON FUSION, NO MATTER THE ODDS

After decades spent watching short-lived bursts of plasma sputter in research-oriented magnetic tokamak reactors, it would be easy to abandon the dream of fusion power. But the ultimate clean-energy technology may be getting closer. ITER (the letters don't stand for anything, but the word means "the way" in Latin) is expected to be the world's biggest tokamak when it's completed in southern France in 2018, and it could lead to efficient prototype power plants. Next year, the array of 192 lasers that form the heart of the National Ignition Facility (NIF) at California's Lawrence Livermore National Laboratory will begin firing at a tiny hydrogen target, testing a magnet-free fusion scheme. NIF director Ed Moses hopes that within a few years, the machine will release 20 times more energy than it consumes. "If this works, over the next couple of decades we can change the geopolitical story," he says.

TEST ANTI-ASTEROID TECH

This past March, a 154-foot-wide asteroid came within 48,800 miles of Earth, just twice the altitude of some satellites. It was big enough to destroy a city. No one saw it coming. Not that it would have helped: There's no procedure in place for deflecting space rocks, just a list of concepts. But two astronauts—Rusty Schweickart, chairman of the Association of Space Explorers–Near Earth Object Committee, and Thomas D. Jones, a PM contributing editor—have a plan. (**1**) Build more asteroid-hunting telescopes. Projects that need more funding include a Canadian space-based telescope and a series of ground-based systems in Hawaii. (**2**) Assign asteroid-deflection authority to an international committee. With no one in

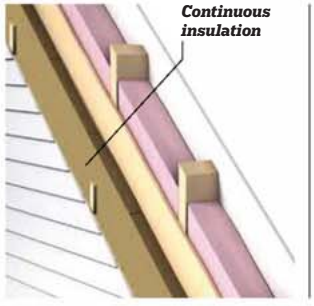
Build Homes That Don't Need Furnaces

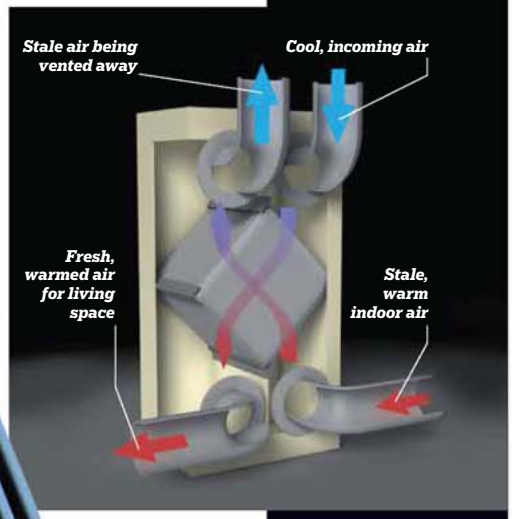
The conventional American home bleeds heat from under doors and around window sashes—and right through underinsulated walls. While wind turbines and solar panels are impressive green technologies, the way to really slash one's bills and environmental impact is to live in a hyperefficient house—and it doesn't get more hyper than the "passive houses" now being developed. These are essentially maximum-security prisons for thermal energy, with thick insulation that leaves no unprotected studs to conduct heat to the outdoors, triple-pane windows and an overall approach to airtightness that lunar colonies could aspire to. In Europe, as many as 6000 homes have been passive-house-certified in the past decade, with thousands more approaching, though not quite meeting, the rigorous requirements. According to energy-efficiency consultant David White, a passive house in the northeastern United States could consume 90 percent less heat than equivalent homes. "Passive houses have been shown to be among the most reliable and cost-effective approaches to efficiency," White says. In Germany, off-the-shelf windows, gaskets and other passive-house-certified products have brought construction costs to within 5 percent of those for conventional homes. In the United States, that price premium can be 11 percent or more. White sees that number coming down. Since quitting his job at a green design firm to concentrate on passive housing projects, he's been working 18-hour days to keep up with an influx of new customers. The housing market may have crashed, but passive houses are on the rise.

CONTINUOUS INSULATION *Loft insulation is used between studs. An unbroken layer of insulation on the outside wall ensures that the studs don't act as thermal bridges, conducting heat outside.*

HEAT EXCHANGER *Airflow in and out of the house is carefully controlled. Fresh air is routed through a heat exchanger; it is warmed by air being vented outside.*

TRIPLE-PANE WINDOWS *Window frames are surrounded by multiple layers of foam; gaskets have some flexibility, ensuring a tight, enduring fit.*





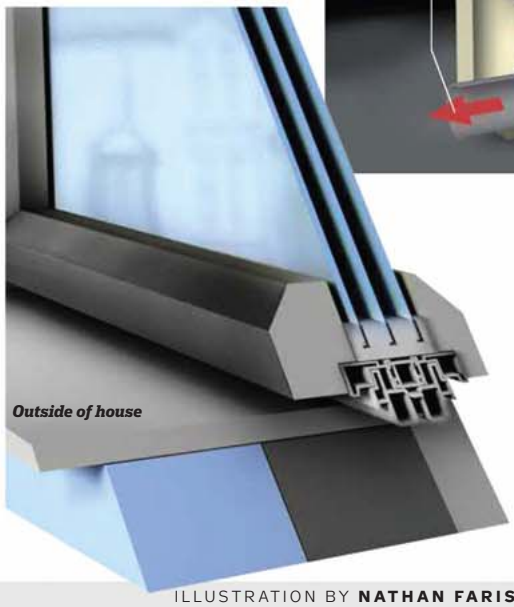


ILLUSTRATION BY **NATHAN FARISS**

IF PM RAN THE WORLD



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VOLUNTEER: THE WORLD NEEDS YOUR HANDS-ON SKILLS

Coach Newbie Car Shoppers

Ways to Work, a national group that helps low-income people solve commuting problems, is looking for mechanics, savvy car buyers—anyone who can tell a dirt-cheap bargain from a ticking time bomb of a lemon. Volunteers tag along with low-income drivers as they shop for an inexpensive ride for traveling to and from their jobs. *SKILL SET: General car knowledge (the more the better). Time commitment: An hour or less, as often as or as rarely as you're available.*

Repair Family Breakdowns

Volunteer mechanics and contractors in Tacoma, Wash., have been lending a hand to families who can't afford home and/or car repairs, through a nonprofit group called Need-A-Break Services. There are similar, equally worthwhile groups located throughout the United States. *SKILL SET: Professional construction or mechanical experience. Time commitment: Up to a full day per project.*

Mentor Teen Roboticists

Inventor Dean Kamen looks forward to the day when engineering chops impart as much high school cachet as the ability to dunk a basketball. About 1700 teams compete each year in the FIRST Robotics Competition, the robot league he founded. Matches are full-contact, metal-on-metal sporting events. The high school teams need mentors, as do participants in several other FIRST competitions, including the FIRST Lego League. *SKILL SET: Mechanical and/or programming abilities help, as does a knack for cheering. Time commitment: Potentially big. Imagine coaching a high school varsity sports team.*



Juan Belliard (kneeling), an engineer with the New York City Transit Authority, volunteers as a mentor with the Robodogs, a 2-year-old robotics team from Long Island City High School. In 2009, the team made it to the national finals. Belliard's advice: "Work together as a team—and keep it simple."

charge, individual nations might launch Pyrrhic schemes: "In the past, there was a Russian proposal to have a 50-megaton nuclear missile in the silo, ready to launch at any asteroid that shows up," Jones says. Bad idea—it could create a lethal storm of fragments. (3) Run a rehearsal mission. One plan is to park an unmanned spacecraft alongside the offending asteroid, while kinetic impactors—guided missiles minus the warheads—slam into it. The first craft helps the impactors target the object and acts as a gravity tractor, using its mass to nudge the rock off course. If something really huge heads our way, we could always resort to that 50-megaton nuke tactic—with luck the bomb would ignite gases in the asteroid that would spew outwards and nudge the rock from its apocalyptic path.

SWAP OUT MPG FUEL RATINGS FOR G/100M

Quick, which is better: Replacing an 18 mpg car with a 28 mpg ride, or going from 34 mpg to 50 mpg? Researchers say that drivers find it easier to get the right answer when efficiency is expressed as gallons per 100 miles (g/100m). Eighteen mpg versus 28 mpg becomes 5.5 g/100m versus 3.6 g/100m, for a savings of 2 gallons every 100 miles. Going from 34 mpg to 50 mpg is the same as switching from 2.9 g/100m to 2 g/100m—only half as big a gain. Such ratings already are common in Europe.

DEPLOY TINY ROBO-DOCS

"Smart pills" designed to carry miniature cameras or doses of medicine have been kicking around laboratories for years. Now researchers are homing in on a Lilliputian robot doctor that could do it all, combining diagnostic imaging with targeted drug delivery, while precisely navigating a patient's digestive track. A model from Pittsburgh's Carnegie Mellon University anchors itself within the body using adhesives, while another device (invented in Germany) is guided by magnets outside the body. When such bots hit clinics, they should make biopsies easier, and colonoscopies mercifully obsolete.

NETWORK CARS WIRELESSLY

Cars are becoming chatterboxes. They intone directions, pause music to announce incoming calls, and soon will start reading e-mails aloud. But now GM, Volkswagen and other automakers want cars to talk quietly among themselves. Vehicle-to-vehicle (V2V) communications systems will enable cars to trade news of hazards such as black ice or a truck broken down on a blind curve. The information will be projected for drivers onto the windshield or shown on a dashboard display. V2V could also help steer drivers clear of traffic snarls. Tests have been run in California and Germany; the next step is to agree on an industry-wide protocol.

PHOTOGRAPH BY **BEN BAKER**



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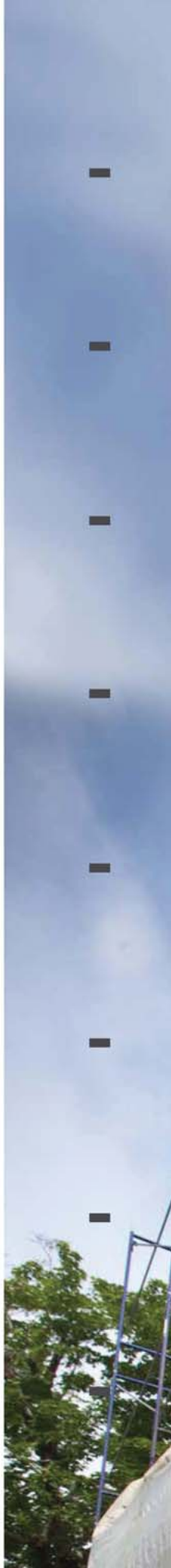


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BRICK BY BRICK

OBSESSIVE HISTORIC PRESERVATION AND RENEWABLE ENERGY SYSTEMS BRING A CLASSIC RHODE ISLAND FIREHOUSE FROM THE 19TH CENTURY STRAIGHT INTO THE 21ST.

BY LISA PALMER



Not your typical teardown. To reconstruct this landmarked building, the homeowner used 3D laser imaging that measures, to within 2 millimeters, where the original bricks should be placed.

"THE ONLY THING KEEPING THE BRICKS IN PLACE WAS gravity," David Hacin says. Hacin, the architect in charge of preserving the historic Newport, R.I., firehouse, shared his observation with homeowner Clint Clemens shortly after removing the structure's roof. Clemens peered inside the 1-foot-thick outer wall to see for himself: The interior mortar, which had been made from local beach sand when the building was constructed in 1887, had turned to a fine dust.

Clemens and his wife have a history of living in unique homes. Their first was an 800-square-foot converted chicken coop on the former farm of John Quincy Adams. More recently, they lived in a lighthouse in Tiverton, R.I. So when the firehouse appeared on the market in 2006, they could immediately picture themselves living there—only buying a historic landmark involved more work than they realized. "It's like signing up for the military," Clemens says. "You're in it for four years."

Known locally as Redwood Hose 8, the firehouse had last seen active duty in 1912. And although it was now a crumbling ruin, it sat smack in the middle of Historic Hill, Newport's National Historic Landmark District, so simply demolishing it was not an option. Clemens, a commercial photographer and owner of a 3D imaging company, decided to preserve the building with the tools he knew best. Using a Faro 880 laser attached to a tripod, Clemens fired off 30 million measurements along three sides of the home. This enabled him to create a 3D image of the two-story structure accurate to 2 millimeters—and to rebuild it with the same precision.

Contractors dismantled Hose 8 brick by brick, lowering the

PHOTOGRAPHS BY CLINT CLEMENS



masonry to the ground one bucket at a time, until nothing was left but the building's foundation. Each brick was painstakingly cleaned, tested for strength and stored—until, as Hacin put it, the time came to "put Humpty Dumpty together again."

Clemens was determined to reduce his new home's carbon-dioxide emissions to near zero. So to control the building's climate, he chose to install a geothermal system that would take advantage of the natural temperature gradient deep underground. That proved a challenge as well. First, a 55-foot-long truck had to be maneuvered up a one-way urban street. Then, for three long days, metal rammed earth, until the drill finally bored into a geothermal aquifer 850 feet below the surface. Relief from the noise came in the form of a geyser, shooting 200 feet in the air at 150 gallons per minute.

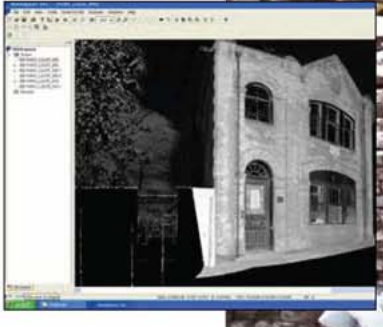
The open-loop geothermal system supplies radiant heat to the floors and to a forced-hot-air system. Flip a switch, and 45 minutes later (as Clemens times it) the system pumps cool air into the home. Though the $32,000 geothermal system is considerably more expensive than traditional HVAC, a 30 percent tax credit this year will offset the costs. Clemens estimates the system will pay for itself in six years and last more than 30.

A solar thermal array that sits discreetly on the roof supplies all of the home's hot water; extra solar heat is redirected into radiant-heat flooring in the basement. An exterior propane tank supplies fuel for the kitchen stove, and Clemens purchases wind-generated power to supply all of the electricity.

Most of the wood in the home has been certified by the Forest Stewardship Council, while other materials were repurposed from the original building—including many of the bricks, the roof capstones and a few of the windows. The brick

1

After Clint Clemens bought a 119-year-old firehouse in Newport, R.I., to renovate for his home, he learned that the crumbling mortar meant the entire structure was unsound. Demolishing the historic building wasn't an option, so Clemens, vice president of the 3D imaging company Models From Mars, applied a high-tech solution to the century-old construction problem. He measured the precise dimensions of the original structure with a Faro 880 laser—then used the resulting 3D image (below) to convince the town's firmly preservation-minded historic commission that the firehouse could be totally dismantled and rebuilt to the same specifications.



2

Deconstructing the firehouse one brick at a time was a test of both patience and physics. Workers took measures to stabilize joists (below) while removing individual bricks from the building's exterior. Windows that couldn't be salvaged were reproduced with exact details, down to the weighted sash and antique glass. "This is a historic structure, a work of art," Clemens says. "We are simply stewards of the building, caring for it like you would a fine painting." More than a century of deterioration forced Clemens to work his way back to a blank canvas.



3

The sorted and stacked bricks (below) are only a fraction of the 28,000 total bricks that workers salvaged for the reconstruction. The original walls were four layers thick, as opposed to one layer for the rebuild, so the teardown produced thousands more bricks than needed. Neighbors carted off extras to be reused for patios and walkways.





4

The original mortar and foundation (above) contained local beach sand—seashells and all. Sistered joists against the walls shored up unstable footings.

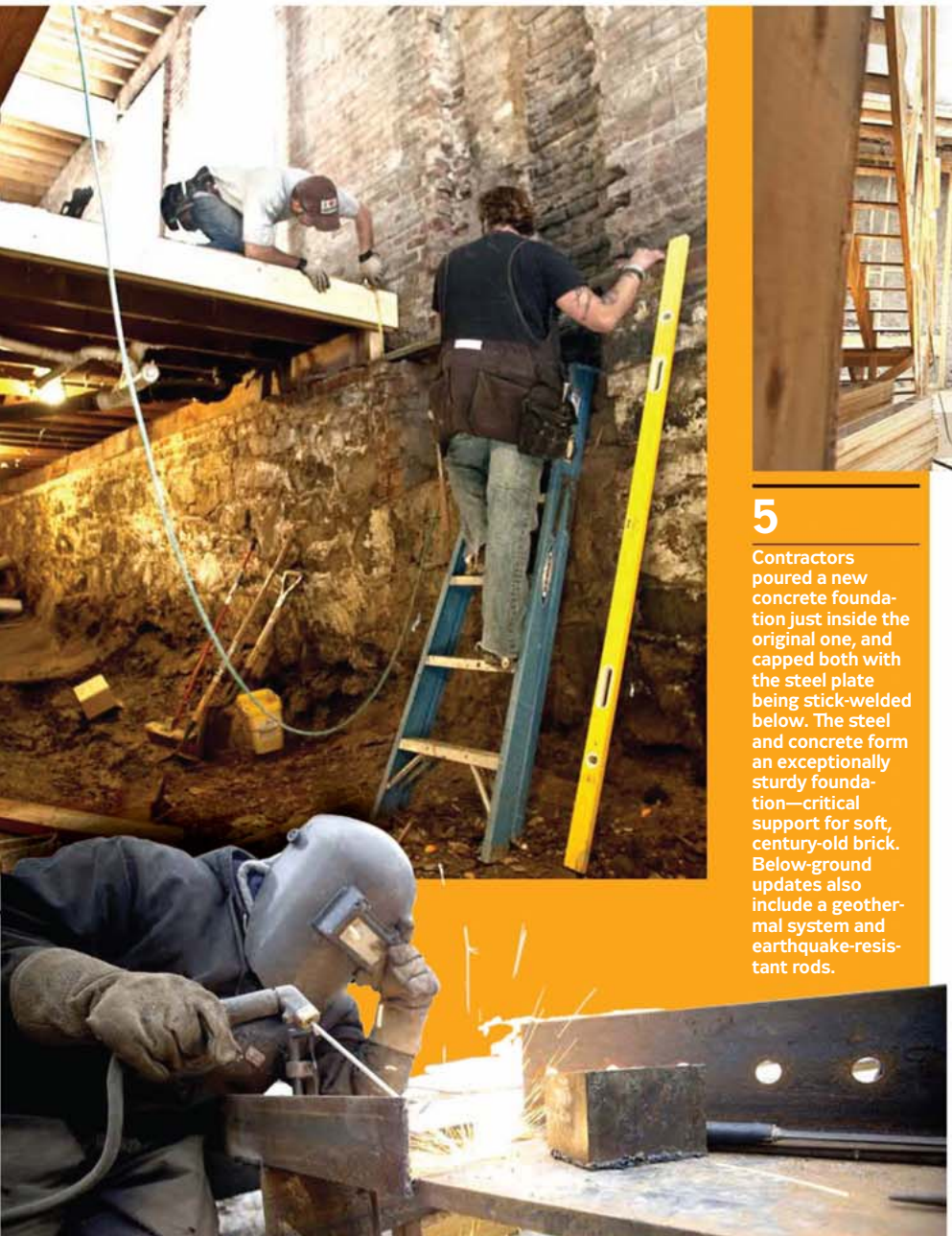
exterior is now a veneer covering a wooden structure—not four layers thick, as in the previous construction.

In order to preserve the building's outward appearance, contractors poured a 19-inch-wide concrete trench inside the original fieldstone foundation. Then, they installed a 1-inch-thick steel plate that caps both structures. While Hose 8 appears to sit atop its fieldstone roots, that's an illusion. The steel plate acts as a cantilever, so the building's weight actually rests on the new concrete base. Stabilization rods extend from the roof to the foundation, ensuring that the house meets earthquake codes. It is also rated to withstand winds up to 200 miles per hour. The home's upgrades, Hacin says, "would have been impossible in renovating the existing building."

Inside, insulation packed into the walls increases efficiency while also muffling sound. With no hum from a furnace, the house is so quiet, Clemens says, it's "like you have a pillow over your ears." The home has been engineered as a box, so the interior walls can be reconfigured based on the changing needs of the owners over time. Currently, the French doors of the top-floor master bedroom open to a deck that overlooks the steeple of the neighboring Channing Memorial Church, built in 1880.

Clerestory windows, located high on the south wall of the first and second floors, allow daylight to filter through the interior, reducing the need for electric lighting. Natural light from a copper-trimmed skylight floods the upper levels.

It was supposed to be a straightforward renovation, but turning a former firehouse into a single-family home became a lesson in fortitude instead. Two and a half years later, Hose 8 is a cutting-edge green building—and, thanks to Clemens's 3D vision, looks exactly like it did more than 100 years ago. **PM**





5

Contractors poured a new concrete foundation just inside the original one, and capped both with the steel plate being stick-welded below. The steel and concrete form an exceptionally sturdy foundation—critical support for soft, century-old brick. Below-ground updates also include a geothermal system and earthquake-resistant rods.

6

Cellulose insulation made from recycled newspaper fills the 12-inch-thick wood-framed walls (above). Hose 8's exterior brickwork (below) looks like it did before the epic project began. With the restoration, the building may last another 120 years.





WELCOME TO THE FOOD CHAIN

THE GOOD NEWS: ONCE-ENDANGERED PREDATORS ARE MAKING A COMEBACK. THE BAD NEWS: THEIR FAVORITE HABITAT MIGHT BE YOUR BACKYARD.

IT WAS THE PERFECT ENDING TO A PERFECT AFTERNOON. GARY Mann and his girlfriend Helen were watching the sun go down after a satisfying day clearing brush in the backyard of Mann's home in Sutter Creek, Calif. A pile of branches and twigs was burning merrily, throwing shadows into the growing darkness as the couple's three dogs—a 50-pound Shar-Pei named Tigger and a pair of Rottweiler mixes, Takota and Tenaya—played at their feet.

Mann's home is the kind of place nature lovers dream of. The house is set back from the road on a densely wooded, 10-acre parcel bordered by government land and private property; wild turkeys and deer—up to a dozen at a time—wander through daily. Beyond the backyard lawn, 80 feet from the house, ponderosa and oak grow thickly on the steep slopes of a hill.

That February night, Helen heard crackling and snapping of underbrush and saw something large moving along the edge of the trees. When Tigger went to investigate, with Takota close behind, Mann didn't stop them, even though he

BY ERIN McCARTHY

PHOTOGRAPH BY SIMEN JOHAN

knew mountain lions roamed the area. One had peered through his neighbor's window, scaring the woman inside, and another neighbor had recently seen a big male lion in Mann's driveway. "The lions come in pretty far," Mann says. "Common sense would have said, don't let the dogs go. But I've been living up here for eight years, and it's rare that they attack dogs."

Suddenly, the couple heard Tigger "screaming for her life," Mann says. When he ran down to the edge of the woods, he could only see shadows and fleeting movement in the thick underbrush. Whatever was attacking the Shar-Pei growled at him. Takota rushed in, and then it was over—the animal released Tigger and took off. "We think Takota scared it," Mann says. "It all happened in about 10 seconds."

Tigger's injuries were serious. The skin over her head had been split open to the bone, her left eye almost torn out. Deep claw marks ran down her back. Mann held the wounds closed as he and Helen rushed Tigger to the vet, who confirmed that the injuries had been caused by a mountain lion.

Tigger survived, but since the incident Mann has kept the dogs out of the woods. "I'm still here and the lion is still here," he says. "My neighbors said it was up at their property two nights ago. To attack a dog near a house when two adults are out in the yard with a fire going—that's when you have to start worrying. There are lots of kids just a couple of blocks from here."

WHEN EUROPEANS SETTLED the New World, they dealt with predators by showing them the business end of a gun. Wherever pioneers settled, populations of large predators—mountain lions, bears, wolves, alligators—plummeted or disappeared entirely. That search-and-destroy mission continued virtually unabated until the rise of the environmental movement in the 1960s and '70s, when the national attitude began to evolve. People came to believe that what was left of wilderness and its inhabitants should be preserved for future generations.



Officials in Slidell, La., capture an alligator that bit off an 11-year-old boy's arm as he swam in a local pond. The gator had lived there for years without incident.

PHOTOGRAPH BY SCOTT THRELKELD / THE TIMES-PICAYUNE

This ideology has clearly worked: Since the passage of the Endangered Species Act of 1973, 14 species of animals that were on the brink of extinction have recovered. Alligators were removed from the list in 1987; gray wolves in 2009. The grizzly bear, confined mostly to Yellowstone National Park in the lower 48 states, was delisted in 2007. As for once heavily hunted mountain lions, some 50,000 of the big cats now inhabit North America, with populations in the United States as far east as North Dakota. Experts predict that lions eventually will reinhabit the Adirondacks in New York, the Maine woods and the Great Smoky Mountains of Tennessee.

Few people anticipated that rebounding populations would create a new problem: an increase in animal attacks as predators returned to former ranges now occupied by humans. In August 2002, a black bear killed a 5-month-old girl in the Catskills, a hundred miles northwest of New York City; the baby had been sleeping in a carriage on the porch. In January 2004, a mountain lion killed a male bicyclist in Whiting Ranch Wilderness Park in Orange County, Calif., then attacked a 31-year-old woman a few hours later. Other bicyclists managed to save the victim, but not before she sustained serious injuries. In October 2007, an alligator snatched and killed an 83-year-old woman outside her daughter's home in Savannah, Ga. The next day, her body was found in a pond, hands and a foot missing. And, in May 2008, a coyote bit a 2-year-old girl playing in a Chino Hills, Calif., park and attempted to drag her off.

Though the trend is worrisome, the absolute number of attacks remains small. Fatal black bear attacks on humans have doubled since the late 1970s, increasing from one to just two incidents per year. (About six people are injured each year.) Between 1890 and 2008, there were 110 mountain lion attacks in North America; half of the 20 fatalities resulting from these attacks occurred in the past two decades. Despite an alligator population too large to count, the U.S. had just 391 attacks and 18 fatalities between 1948 and 2005. Coyotes have caused only one known fatality in the U.S.

Still, the relationship between animals and

ESCAPE THE BEAST

Animal attacks are rare, but they do happen. Here's how to handle an encounter with big predators and survive—in the backcountry or the backyard.

humans is proving to be more complex than simply kill 'em all or love 'em all—even though some of the old, romantic ideas about living at one with nature linger. "If you ask people why they moved where they did, you discover that they moved to be immersed in nature and wildlife," says Marc Bekoff, professor emeritus of ecology and evolutionary biology at the University of Colorado–Boulder. "The fastest way to decrease the experience is to start killing the animals."

Whether homeowners welcome large animals into their neighborhoods or see them as life-threatening intruders, most people recognize that we've entered a new era: Predators and humans today often share the same terrain, and their daily routines intersect in ways that challenge conventional ideas about man and nature.

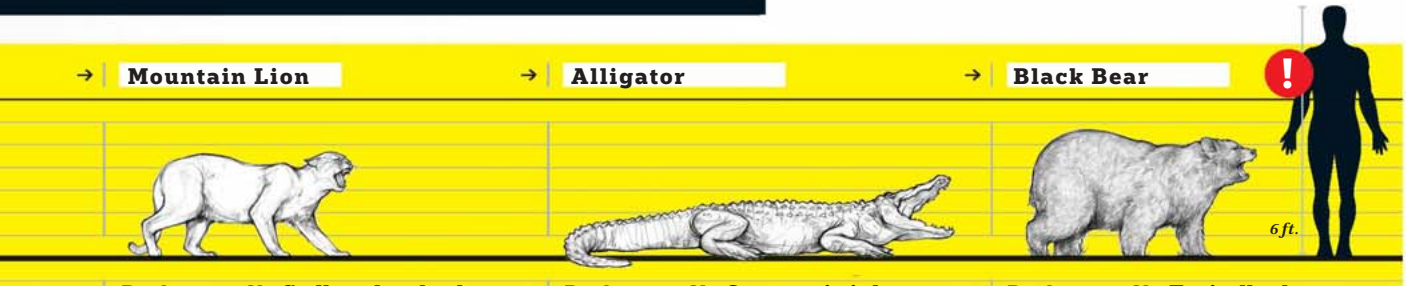
THE CAREFULLY MANICURED lawns of suburban and exurban developments may look domesticated, but they often occupy what were recently wildlands. These transitional zones between habitats, known as ecotones, are expanding at an unprecedented rate—providing more opportunities for human–predator interaction. Urban land area in the U.S. has quadrupled from 15 million acres in 1945 to 60 million in 2002; rural residential land has increased by an average of 1.2 million acres per year since 1980.

But the spread of human populations doesn't necessarily come at the expense of predators. The semiwild environments desired by humans are often equally attractive to apex animals, and in many regions, human and predator populations are growing hand-in-hand. Nowhere is this more evident than in America's gator belt, which extends from North Carolina down through Florida and west to Louisiana and Texas. There, people have moved into the wetlands where alligators live, and they've created ponds and canals within subdivisions that alligators consider appealing habitats.

In July 2008, 11-year-old Devin Funck and two friends escaped the stifling Louisiana heat by taking a dip in Crystal Lake, a flooded former gravel pit in a subdivision near Slidell. Funck was playing in the shallows when an alligator grabbed his arm, dragged him to deeper water and pulled him under. After a struggle, Funck poked the gator in the eye and pulled free, but his left arm was gone, torn off at the shoulder. Friends ran for help, and within an hour emergency responders were rushing the boy to hospital.

According to local news reports, area residents knew the gator lived in the popular swimming hole; in fact, they had even given the 10-foot 8-inch, 500-pound reptile a name—Big Joe. It took nearly 3 hours for hunters to find and kill Big Joe and cut Funck's bluish but intact arm from its stomach. Doctors were unable to reattach the limb, however, and Devin now wears a prosthesis.

Experts can offer no explanation as to why the gator, which had patrolled Crystal Lake for years without incident, attacked Funck. And neither can residents: Two boys who often swam in the lake said that the alligators there usually swim away when approached. "The set of circumstances that takes a human–alligator interaction to the next step, to an attack—we don't know what that trigger is," says University of Florida professor and gator expert Frank Mazzotti.

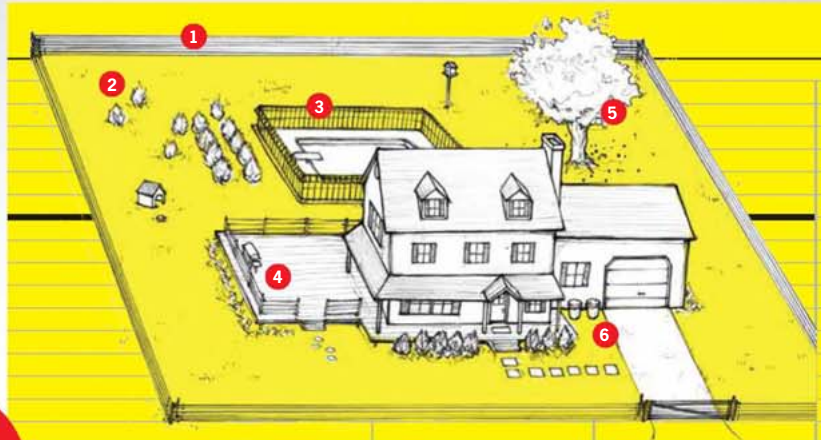


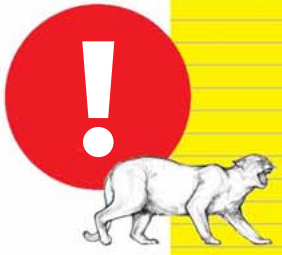
Mountain Lion	Alligator	Black Bear
Predator profile: **Stalk-and-ambush carnivores that usually eat fast, hoofed animals such as deer. (Also known as: cougar, puma, catamount, panther.)** *Tactics:* Cougars incapacitate prey by biting down on the back of the neck, snapping the spine or severing an artery. *Survival strategies:* Never hike or bike trails alone. If you see a mountain lion, don't run—that triggers its pounce reflex. Instead, make yourself look bigger, shout at the lion and back away slowly. Grab something to defend yourself with, but only if it doesn't require you to get down on all fours, which makes you look vulnerable. If attacked, fight back. Try to gouge a cat's eyes or suffocate it—its windpipe is superficial and can be compressed.	*Predator profile:* **Opportunistic hunters that eat what is readily available and easily overpowered.** *Tactics:* In a defensive attack, a gator bites an intruder and lets it go as a warning. In a predatory attack, alligators grab prey and pull it underwater, then engage in what's known as a death roll—spinning the prey over and over until it is incapacitated. *Survival strategies:* Kick and hit the alligator; go for eyes and other sensitive areas. Gators are not well equipped to capture prey on land but still move quickly. Urban myth says to run in a zigzag to escape, but there's no proof that's effective; just run away as fast as you can.	*Predator profile:* **Typically shy omnivores that need high-quality food to create fat for hibernation.** *Tactics:* In a defensive attack, a bear makes short charges, clicks its teeth and growls. In a predatory attack, a bear pursues you persistently and quietly. *Survival strategies:* Defensive attack: Wait till the bear stops moving, then back away slowly. Repeat this strategy until you're out of its sight. Predatory: Make yourself look as big as possible by standing taller and opening up your coat. Throw things at the bear and make noise. Don't run; this can trigger an attack. In the wild, always carry bear spray, and don't hike alone.

ILLUSTRATIONS BY **WESLEY EGGEBRECHT**

PREDATOR-PROOF YOUR YARD

Use wildlife smarts and DIY know-how to make your yard a predator-free zone.





1. Consider setting up a high-voltage, low-amperage electric fence or tripwire along the border of the lawn. The jolts and loud sounds keep most predators away. For kits, visit *margosupplies.com*.

2. To discourage deer from lingering in your yard, landscape with plants they won't eat, such as boxwood, hellebore, butterfly bushes and barberry.

3. Keep gators out of your pool by enclosing it with a fence topped by foot-tall 45-degree arms that angle out—toward an approaching alligator.

4. After a cookout, roll your grill into the garage—food smells attract bears. Store bags of birdseed and dog food in the garage or house. Before you retire for the night, bring in dog bowls and take down bird feeders.

5. Keep the ground under your fruit trees clear. Rotting fruit attracts not only bears, but pests like raccoons, which could carry rabies.

6. Lower the chance of animals getting into your garbage by putting your trash cans out the morning of pickup, not the night before, and invest in critterproof cans, which you can buy at *bearicuda.com*.

AS ANIMALS AND PEOPLE encounter each other more frequently, creatures can lose their sense of fear. It's called habituation—a process by which an animal, after a period of exposure to a stimulus, stops responding. "Through experience, animals learn that people or developments are not threats, so their natural fear decreases," says Tania Lewis, a U.S. Geological Survey biologist at Glacier Bay National Park and Preserve in Alaska.

When animals are no longer afraid of humans, they no longer try to avoid them—and the results can be deadly. In January 1991, 18-year-old Scott Lancaster was killed—and partially eaten—by a mountain lion as he jogged a quarter-mile from his Idaho Springs, Colo., high school. This case and other human–lion interactions in and around Boulder, Colo., were the basis of the book *The Beast in the Garden,* in which author David Baron argues that mountain lions have become habituated. "As wildlife invades suburbs," Baron wrote, "and as suburbs invade wildlife habitat, we are changing animal behavior in unexpected and sometimes troubling ways. Rarely has the behavioral shift been so well documented, as in the case of Boulder's lions." The lions, he argues, weren't afraid of people; in fact, the cats had changed their diets to include pets and sometimes people—and were teaching their offspring to do the same.

University of Northern Arizona professor Paul Beier scoffs at the idea of species-wide mountain lion habituation—as well as the notion that people are now lion prey. "It's just not true," he says. "If people were on the menu, we'd have an attack every day." Though habituation can occur in individual animals, "The idea that it's happening broadly as a phenomenon is not consistent with the number of attacks we see, which is still less than one fatality a year. Every mountain lion has had an opportunity to kill a human, so 99.9 percent of mountain lions don't bother to chomp us."

Beier, who keeps records of mountain lion attacks and has tagged and tracked 32 lions, says all predators experiment with different types of prey. "They have prey that they specialize in eating, but occasionally they'll eat something else—that's how they learn," he says. "If you think about it, that's necessary for animals to evolve. Maybe they're trying something new that's about the size of a deer but has two legs. But, by and large, they don't."

Even if humans don't turn into prey for all predators, the USGS's Lewis—whose husband was Scott Lancaster's classmate—believes habituation does happen, and not just for mountain lions, but for bears, coyotes, alligators and most other animals that regularly come into contact with humans. "Wildlife will habituate," she says. "We have an effect on

each other—whenever people and animals encounter each other, animals learn from that, and that helps shape their behavior the next time they have an encounter."

WHEN SUMMER ROLLS AROUND, our backyards turn into a smorgasbord for wildlife. Uncleaned grills, bird feeders, dog food left on the porch and garbage stuffed into unsecured bins can lure creatures to our doorsteps. And once an animal has an easily obtained meal, it keeps coming back. The process through which animals learn that people are a source of high-quality calories is called food conditioning. "Sometimes wild animals get accustomed to a certain source of food, and they forgo other sources," Bekoff says. "Why hunt for a rabbit when you can get a freebie handout at Joe's?"

This was just the kind of situation Denise Haldeman walked right into in May 2008. She went outside after dark to take down the bird feeders in the backyard of her Barbours, Pa., home. Her dog, Panda, tore into the darkness, but Haldeman thought the 12-year-old Lab mix was chasing another dog that sometimes ran loose in the neighborhood.

Then she saw the black bear. It was standing on its hind legs, just a few feet away, clicking its teeth. As Haldeman turned to flee, the bear struck her from behind, knocking her facedown on the patio. "The bear was standing on me, biting my head," Haldeman later told reporters.

The bear left without attacking her further. Haldeman was treated for wounds on her head, face, arms and legs. Panda was not so lucky; the dog, which had also encountered the bear, died from its injuries. Authorities later determined that Haldeman had unwittingly come between a sow and her cubs; 10 days later the bears, which had previously been seen around the neighborhood, were trapped in Haldeman's yard and relocated about 150 miles away.

Black bears, usually considered far more docile than grizzlies, will typically flee when confronted by a human, says Stephen Herrero, author of *Bear Attacks: Their Causes and Avoidance.* He has been studying bear attacks for 42 years. Food-conditioned black bears can become aggressive—a learned behavior from the wild, where they must defend their food from other bears.

Most attacks are defensive—when people are in a bear's space, it feels uncomfortable and may attack the perceived threat. But some attacks are predatory. "There's the odd black bear—and this is where the fatalities come from—that just decides, Well, I've been eating deer all my life, I think I'll try out that two-legged thing," Herrero says. "That pattern of behavior is very recognizable. The bear walks around, sizes things up, and when it decides to go for it, it goes for it." But most predatory attacks take place in the wilderness. Herrero says that backyard predatory behavior is peculiar, and biologists haven't yet figured out why it's happening.

Though bears are the poster children for food conditioning, they are by no means the only susceptible animals. "Coyotes that have become problems have been fed," Bekoff says. "It's hard to think of any exceptions." In August 1981, a 3-year-old girl from Glendale, Calif., was waiting in the driveway for her father to find his car keys when a coyote grabbed her by the throat. Before the father could chase the animal away, it dragged the toddler through the street; she later died of a broken neck and blood loss. Bekoff, who worked the case, says the neighbors had been feeding the coyote, perhaps in hopes that regular meals would prevent the wild animal from attacking pets. Wolves, raccoons and even alligators can also become food-conditioned.



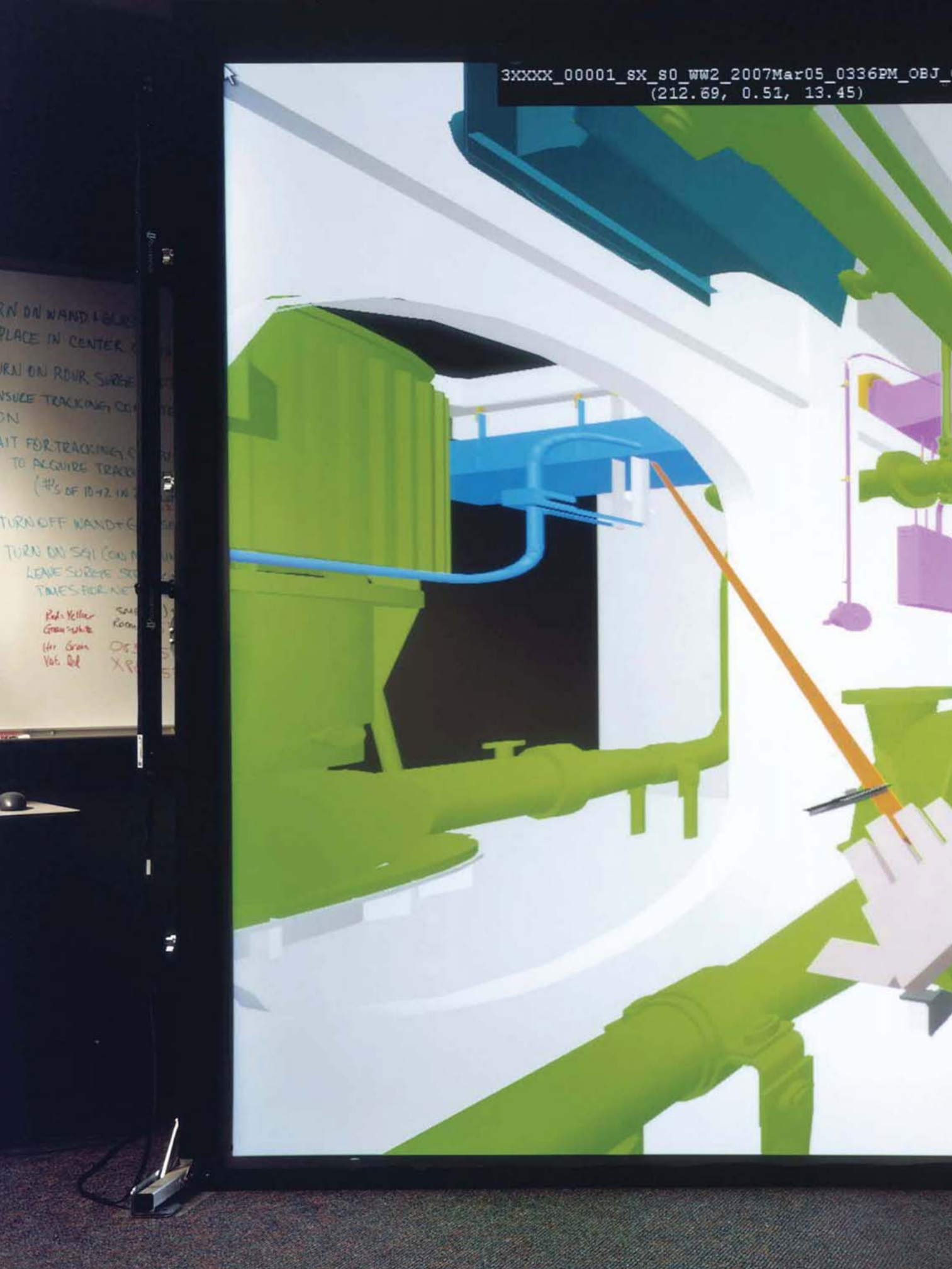
In 2008, Anne Hjelle returned to the trail where she was attacked by a mountain lion four years before. The 122-pound cougar bit Hjelle 40 times; 200 stitches and six surgeries were required to repair the damage to her face.

HUMANITY ISN'T LIKELY to stop expanding into wildlife habitat. Though the risk of a fatal animal attack—or any animal attack—is less than the chance of getting struck by lightning (1 in 400,000), every time we step in the water in Florida, or jog alone in mountain lion territory, we are at risk. So how can we successfully live in this deceptively tame-looking new wilderness?

Most biologists argue that the simplest solution—eradicating predators—would be counterproductive. "If you kill animals, other animals come in," Bekoff says, pointing out that wolves once kept coyote populations in check, and without that natural predator, coyote populations have exploded. Besides, Bekoff says, "people are against the wanton killing of these animals."

The key, then, might be to adapt ourselves. "We live with wildlife, and when we choose to build our house in the middle of the forest, we've now put our house in their backyard," says Charles Schwartz, a research wildlife biologist at Montana State University. Predators once roamed the land unchallenged, yet if we're smart—giving animals the respect they deserve and reconsidering how we dispose of garbage, what foliage we plant—we can live together.

"They're wild animals, and they're predators," Mazzotti says. "Treating them with that small amount of respect and intelligence is the best thing we can do to live with them." **PM**


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Supercarrier

TO DESIGN THE NAVY'S NEW FORD-CLASS AIRCRAFT CARRIER, ARCHITECTS RELY ON VIRTUAL REALITY TO SHAPE 54,000 TONS OF STEEL INTO THE WORLD'S MOST POWERFUL WARSHIP.

By Noah Shachtman

Photographs by Grant Delin

The first pieces of the U.S. Navy's newest class of aircraft carrier—meant to be the cornerstone of American military sea power over the next hundred years—lie in the open air of a shipyard in Virginia. A misting rain is falling on the jumbled field of steel bulkheads, stacks of pipe and 200-ton sections of hull. It's as if some gargantuan child broke apart his model ship and scattered the pieces on the ground.

But Northrop Grumman's staff at the Newport News shipyard know where every part is located—and the exact order in which each piece must be connected. Building an aircraft carrier is like putting together a 3D jigsaw puzzle, for years on end. Engineers have been designing some of the pieces since 2000; the job won't be finished until 2015.

And on a complex project of this scale, there is little margin to correct design mistakes. If not found and fixed, one small flaw can have ramifications that cost tens of millions of

Ship architects in Virginia step into virtual-reality blueprints to perfect the design of the U.S. Navy's first new carrier class in 40 years. Working in 3D reduces errors and oversights on a $14 billion project.

dollars, months of hot-metal work or even the life of a sailor not yet born. "These ships are like entire planned cities," says Eric Wertheim, editor of *The Naval Institute Guide to Combat Fleets of the World.* "It's like building Disney World."

For more than six decades, aircraft carriers have been involved in virtually every major American military engagement, from World War II to the current conflicts in Iraq and Afghanistan. But America's carrier fleet is getting old. Designs for today's Nimitz-class ships began in 1964, and although upgraded, the carriers' steam-powered catapults and cramped quarters belong to another era. So, for the first time in two generations, the Navy is commissioning a new carrier, named after President Ford, who served with distinction on the carrier *Monterey* during World War II. Following custom, each subsequent ship constructed to these specs will be named after him: the Ford class of carriers.

Building a supercarrier is a uniquely American enterprise. There are 21 aircraft carriers in service around the globe; 11 belong to the United States. A few other nations—Britain, Spain and India—have plans to build aircraft carriers. But no one else makes them this large or with such advanced capabilities. No one else is about to try.

The last time American engineers designed a carrier from scratch, in the 1960s, they drew the ship in ink and built full-scale wooden models to prove their designs. Then, the construction-yard workers had to figure out how to put the ship together. Things work a little differently in 2009. Now, engineers and foremen can wander around a mockup of the ship without wearing helmets or boots. All they have to do is slip on chunky black glasses, stare at a screen and step inside the ship's CAD plan.

Sam Vreeland, the *Ford*'s jowly, red-cheeked construction director, hands me a pair of the bulky glasses. We're in a black-walled room inside a nondescript building at the shipyard. On an 8-foot-tall screen in the center of the room, engineers from around the country meet—without leaving their offices—to perfect blueprints in virtual-reality simulators. In front of me is a virtual 3D model of every element of the ship's jet-fuel room, from pumps and pipes to shims and studs securing bulkheads. In the lower decks, engineers have assigned a part number and a supplier to every one of these digital pieces. "We got this technology because we can walk anybody through, including the Navy," Vreeland says. "They can see it more clearly than with a mockup."

Penn State University research associate Vaughn Whisker appears on the screen to my left. Or at least his unshaven, black-clad avatar does. It waves from University Park, Pa., 400 miles northwest, where Whisker is stomping around a 10-foot-square room lined with virtual-reality screens. In the digital fuel room, the avatar reaches up for a pipe to make sure it's in the right place. Then he moves behind a pump to ensure that maintenance workers will be able to fit behind it.

With another mouse click, any designer with access to the CAD file can see the room from the point of view of future crewmen, ensuring that pipes and open hatches don't impede lines of sight to gauges or alarms, or the hand signals of shipmates at their stations. "We always had to find the

Work in Progress Slabs of steel brought by rail to the Newport News shipyard in Virginia wait to be cut, pressed and curved into the hull of the USS *Ford,* which is scheduled to launch in 2015. The annotated model (opposite) highlights the carrier's most critical new systems.



engineering balance," says Lin "Yank" Rutherford, a former rear admiral and the shipyard's director of platform integration. "But in the past there was some subjective thinking."

I reach out with pixelated hands, grab the pump and toss it across the room. Then I spin the lighting fixtures around and tilt the floor. If the Northrop designers wanted to incorporate my horseplay, they would dump the data into the CAD system and ship it 2.5 miles to the fabrication plant at the other end of the shipyard, where metal is shaped to the exact specifications called for by the digital blueprint.

Engineers are using other sophisticated software to synch the ship's design with its future operation. On the flight deck, for example, shipbuilders test the way aircraft are brought to the deck and readied for launch. The Ford is utilizing a new, NASCAR-like pitstop approach. On Nimitz-class carriers, airplanes are dragged all over the flight deck for fuel refills, weapon reloads and maintenance checks. On the *Ford,* workers will handle all those jobs in a single spot. The Navy hopes these measures will increase sorties from the ship by 25 percent—up to 270 per day.

Everything on the *Ford* is subject to simulation testing, from the views of the flight deck from the bridge to damage control in the engine rooms. According to manager of engineering David Rockey, there are even messing models. "That's where we see how long it takes crew members to get a hot lunch and come back [to their stations]," Rockey says. "It's like *SimCity* for carriers." But this game has a serious purpose: "Before we cut steel and pay the bill, we want to see what we're going to get for our efforts."

Eventually, this pixelated world meets the real one. Vreeland and I walk into the fabrication plant to see the raw metal, brought in by the trainload, formed into parts of the hull. It's a cavernous, clanging, hissing 34,600-square-foot shop with dross, sparks and metal scraps all around. Everyone calls out, "Hey, Sam-may!" as we walk by; Vreeland, a Virginia native, has been at the yard since 1972, working his way up from apprentice on Los Angeles–class subs to become the *Ford*'s head of construction in 2000.

One worker, dressed in plaid, looks into a computer screen that displays data from a CAD file. The software guides a cutting machine's jet of plasma gas over a long, low tub. The water below gurgles and flashes purple before draining to reveal a steel plate. There's a big, beveled oval cut in the center and lots of smaller holes for pipes and wiring. It's the virtual carrier, starting to come to life.

We exit the plant and step into a company van. Vreeland drives along the waterfront, zipping over worn rails and past low-slung brick buildings and corrugated factories. On the ground are two 200-ton pieces of the hull, curved on one side, flat and toothy on the other. Put them together, and they become a superlift—a piece of the carrier that is ready to be fit into the puzzle. The shipyard needs to assemble 162 superlifts to create the hull.

And just about the only machine on the planet than can handle these massive parts is the powder-blue, 23-story gantry crane under which we're driving. Riding on rails eight football fields long, the rectangular crane uses three hooks, each capable of lifting more than 300 tons, to pick up ship

New Nuclear Powerplant

Newly designed reactor generates three times the power of those on current carriers, with fewer crew needed for maintenance and operation.

Smarter Fuel Management

The crew monitors refueling aircraft with programmable consoles; an improved filtration system keeps impurities out of jet fuel.

Electromagnetic Aircraft Launch System

A powerful electric motor generates a 3-second 150 megawatt pulse, which drives a movable shuttle that propels planes from the deck.

Improved Island

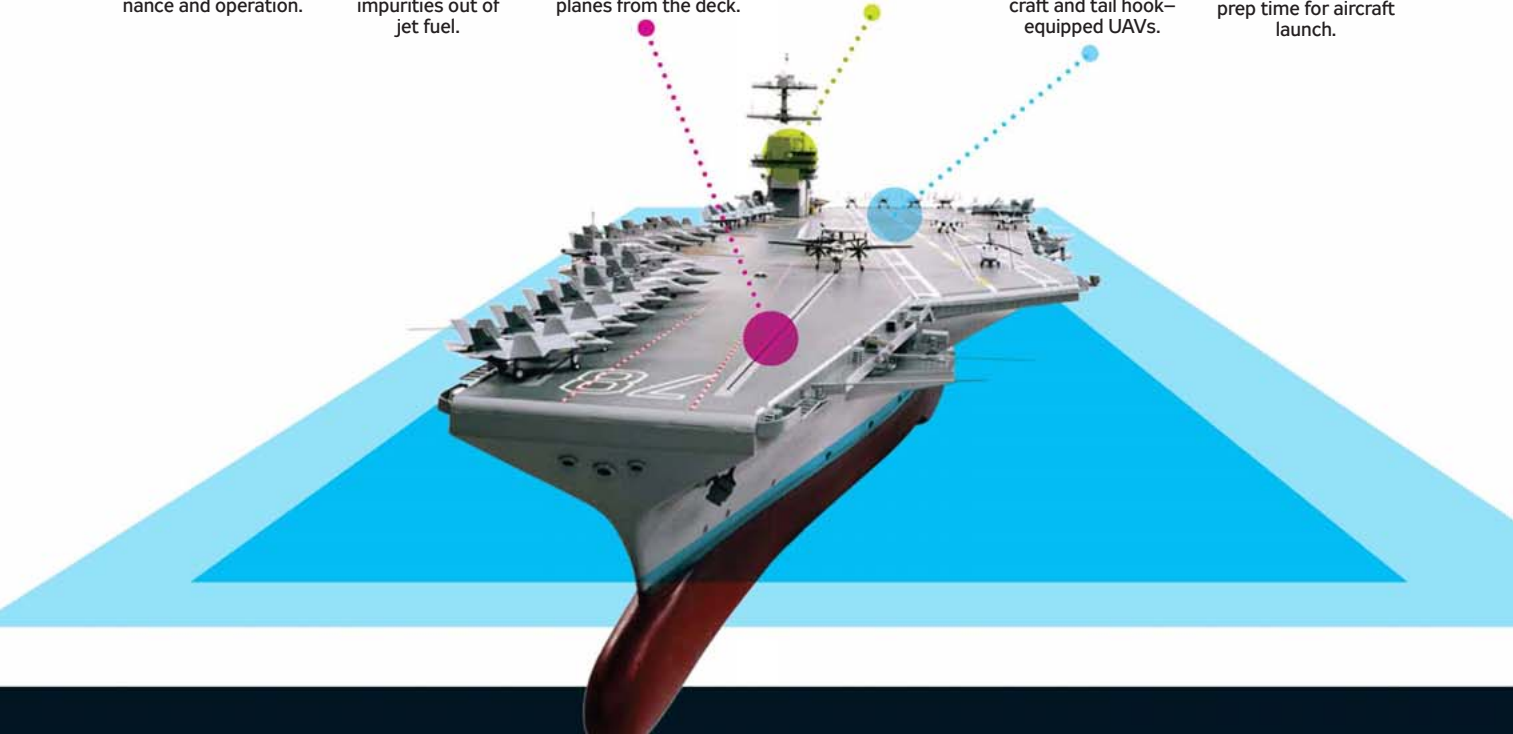
Closer to stern and starboard; smaller than islands on current carriers to increase flight-deck space; houses new dual-band radar.

Advanced Arresting Gear

Replaces current mechanical hydraulic ram system with energy-absorbing water turbines that work with manned craft and tail hook–equipped UAVs.

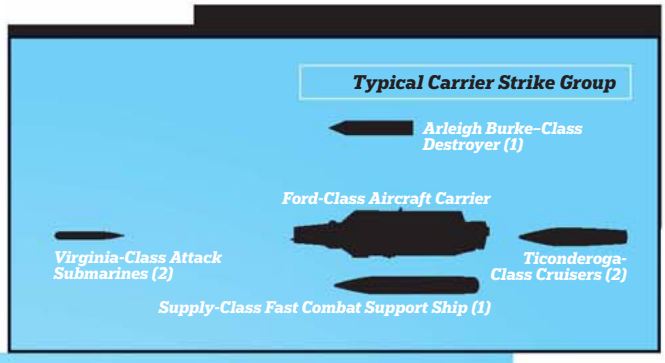
Time-Saving Elevators

It's the NASCAR pitstop model: Elevators lift weapons and fighter jets to the deck at the same location to speed prep time for aircraft launch.



Carrier-Killer Defense

Will America's enemies be able to sink the Navy's next-generation aircraft carriers? The answer is debatable, but it's inarguable that potentially hostile nations are developing—and exporting—weapons for the task. And tactics are evolving: Think-tank researchers and military intelligence professionals follow Chinese military journals for the latest theories on stopping U.S. aircraft carriers. The Navy then incorporates new defenses to thwart these emerging threats.



THREATS



Decoy: The first step in killing a carrier is to confuse the escorts that protect it. The cheapest way to do this—decoys. Covert teams in fishing trawlers, for example, can drop buoys that are programmed to emit delayed radio signals to misdirect a carrier group's defensive ships and aircraft.



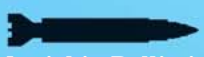
Antiradar Drone: Unmanned aircraft can blind a carrier's escort ships. The Harpy, a drone that Israel sold to China in 2004, circles an area, seeking radar signatures, which it then targets with a kamikaze attack. Without radar, escorts can't find and shoot down antiship missiles.



Diesel Submarine: These quiet, lethal menaces can evade detection, especially in shallow water, and fire Sizzler missiles (a NATO designation) that skim the waves at supersonic speeds. Iran operates Russian-made diesel subs; Pakistan has purchased French-made Scorpions. China is the biggest enthusiast: It built 14 diesel subs in 2006 alone.



Su-30 Flanker: Russian-made airplanes have long been designed to attack carrier groups. The Su-30 can fire barrages of missiles to overwhelm an aircraft carrier's defenses. In 2011 the Russians plan to export an upgraded version called the Super Flanker.



Antiship Ballistic Missile: By 2015 Chinese medium-range ASBMs may target carriers. Over-the-horizon radar could identify ships by bouncing signals off the ionosphere or by propagating signals over the ocean surface. Dong Feng 21 missiles are designed to use onboard radar to find carriers and close in at a high Mach speed.

DEFENSE



E-2C Hawkeye: To defeat decoys, carrier-launched surveillance airplanes with high-power radar can confirm the presence of approaching enemy ships and aircraft. As they gather fresh data from the air, Hawkeyes also direct warplanes and surface ships.



Arleigh Burke Destroyer: Engineers are upgrading destroyer sensors to spot multiple threats, including small ones like drones. A phased-array radar, which can track 100 targets at once, operates in the S-Band frequency range, allowing optimal performance in any weather conditions. The objective: Find and destroy drones before they can strike.



SH-60 Seahawk: Helicopters deploy sensors called sonobuoys to detect acoustic, sonar, thermal or magnetic signatures of submerged submarines. Instead of dipping a sonobuoy into the water, expendable modern versions are dropped from helicopters like the Seahawk. Remotely operated boats are also used to drag arrays in search of enemy subs.



F-35C Lightning II: When it comes to defending the airspace around a carrier, the F-35C is expected to carry the load for the Navy. The stealth airplane is made to kill foes before being seen. However, it is not an agile, cannon-equipped dogfighter like the F-18A Super Hornet, which it will replace in 2015.



Aegis Cruiser: Ship-based ballistic-missile defenses have come a long way. Some Ticonderoga-class Aegis cruisers carry SM-2s that can shoot down inbound warheads in the final stages of flight. New SM-3s engage targets even earlier—in their midcourse stage.

ILLUSTRATION BY **AXEL PFAENDER**

parts. But even that 900-ton capacity—the largest in the Western Hemisphere—wasn't big enough for the *Ford.* So Northrop upgraded the crane's maximum haul to 1050 tons.

The shipyard is obsessed with the timelines of any big-dollar project, and the *Ford* is easily the biggest. The first Ford-class carrier will cost $14 billion, including $5 billion for research and development; Navy officials say the price will drop to around $6 billion per ship with subsequent builds. Delays—and so far the Ford program has suffered two years' worth of them—can mean losing skilled workers and support from Congress or the Pentagon. As the largest items in the Pentagon's shipbuilding budget, new carriers are tempting targets for cutbacks. Some defense analysts are already wondering why the U.S. needs a 100,000-ton monster carrier when our most prominent current enemies are terrorists, small guerrilla bands and pirates in skiffs.



Using a 23-story gantry crane, the largest in the Western Hemisphere, workers maneuver a structural unit into place.

Another controversy surrounding the Ford program is whether this is the right time for a new design. "Do we know enough about future threats?" Wertheim asks. "By 2060, are we even going to have manned fighters? We're really at a crossroads." Although Wertheim thinks the new carrier program could have waited 10 years to get a better idea of the future needs of the ship, he notes that the construction is progressing well. "So far, so good," he says. "But on these huge programs, it's inevitable that they have hang-ups. When that happens, you can't see it as a failure for the whole program."

When the *Ford* is completed, it won't look much different from carriers built for the Cold War. However, there will be striking changes inside. The *Ford* is the first to greatly reduce aircraft carriers' reliance on steam. Nearly everything done on the Nimitz class—heating cabins, drying laundry, propelling the ship, making potable water, launching jets—is done with steam power generated by a nuclear reactor. All that steam means gangs of sailors to operate valves, read gauges and fix machines when they invariably wear down or spring a leak. On the *Ford,* many of those systems will be electric.

The most novel use of electricity occurs on the flight deck. Steam-powered catapults currently do not provide heavier aircraft with enough acceleration to take off, so the carrier cranks up the knots to increase wind speed over the deck. On Ford-class vessels, four linear motors will create magnetic waves that propel the catapult, with each jet getting a customized shove into the sky. Planes will land as they do now, by hooking onto arresting cables, but the system that slows their speed will be electromechanical rather than just hydraulic. These novel designs come with risks. According to the Government Accountability Office, developing the launch system's generator has led to a 15-month delay.

The Navy hopes these developmental risks will be rewarded with long-term savings, especially from the decrease in manpower. On old carriers, it takes gangs of men to move food, laundry, spare parts and ordnance. On the *Ford,* forklifts, not sailors, will haul supplies. Program managers say the *Ford* will require 700 fewer people than a current carrier, saving as much as $5 billion over the life of the ship.

Protecting those sailors is another concern: The Navy has gone to great lengths to ensure its carriers can take a hit. For 25 days in 2005, engineers with Naval Sea Systems Command conducted classified explosions on the USS *America,* a Kitty Hawk–class carrier that served in Vietnam and the Persian Gulf. The ship eventually flooded and sank in the largest damage-control experiment ever conducted. The Navy says results of that test have been incorporated into the design of the *Ford.*

Later this year the megacrane will lower the first superlift piece into the dry dock where the *Ford* will be assembled. Navy brass, politicians and company officials will gather around the massive section of the hull and make speeches; bands will play martial songs. Then more curved side shells will be outfitted with pipes, lights and as many fixtures as possible before being lowered into the dry dock. One superlift at a time, the USS *Ford* will slowly take on the aspect of a ship. When the carrier's structure is complete from hull to island, the dry dock will be flooded with water from the James River. Tugs will tow the massive, empty vessel to another part of the shipyard for years of wiring and systems integration, freeing up the dock for the construction of the next Ford-class vessel. The process will continue until 2058 or until funding ends.

Every day between now and then, at 12:30 pm, a shrill whistle at the shipyard will blow twice. Workers across Newport News—some wearing coveralls and hard hats, others in virtual-reality goggles and slacks—know it means their lunch break is over. They will head back to their respective corners of the shipyard and get back to work. **PM**

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Save money with a tax credit for a new roof. Just make sure the shingle style qualifies before firing off that first nail.

Tax Credits for the DIYer

THE GOVERNMENT JUST SWEETENED THE DEAL FOR HOMEOWNERS HOPING TO CASH IN ON EFFICIENCY-BOOSTING UPGRADES. HERE'S HOW TO SAVE.

BY ADAM HADHAZY

Fed up by her too-hot or too-cold home in upstate New York, Maggie Maurer insulated her attic and replaced a creaky furnace this February. Right away, her utility bill dropped by nearly a third. But Maurer is looking past the monthly savings to the moment she'll really strike it big: next tax season. A provision in February's American Recovery and Reinvestment Act of 2009 allows homeowners like Maurer to claim tax credits for 30 percent of the materials cost, up to $1500, of energy-efficient upgrades like windows, doors, roofs and insulation. "These tax credits are the primary reason I went ahead with the project," Maurer says.

Tax credits reduce the total amount taxpayers owe the government—they're more valuable than tax deductions, which only offset taxable income. Small projects are capped at $1500, but there is no cap

PHOTOGRAPH BY **SCOTT JONES**

on big jobs such as geothermal heat pumps, solar panels and wind systems. Installation costs for these uncapped projects count toward the credit until 2016. The uncapped credits can wipe out an entire tax burden, but Uncle Sam won't cut a check for the excess. For changes in state and local tax credits, homeowners can check the Database of State Incentives for Renewables & Efficiency (*dsireusa.org*).

Contractors hope the credits will spur homeowner investment. "The credits have definitely given us a little bump in geothermal projects," says Troy Howard of Central Valley Mechanical in Utah. "Interest in solar and wind has picked up."

"For some homeowners who already had energy-efficiency projects in mind, the tax credits have helped push them over the hump," says Michael Rogers, senior vice president of market development with GreenHomes America, which upgraded Maurer's house. "But it's not like we've had people banging down our door because of the federal tax credits," Rogers adds.

Although the program offers a lot, taking advantage of it can be tricky. For example, not all Energy Star–certified doors and windows qualify for the program's strict standards. Categories such as solar- and wind-power systems did not initially list specific models of qualifying products; manufacturers of biomass stoves were still waiting, as of April, for criteria to determine which stoves qualify. Other improvements, like energy-efficient garage-door openers or metering devices to control power consumption, are not included.

Homeowners could make a mistake planning multiple projects—in the capped category, each homeowner has only $1500 to claim for all work combined. Improvements must be "placed in service" during the tax year. Homeowners should keep the Manufacturer's Certification Statement saying the item qualifies for the tax credit. That will make life easier during the next DIY project: filing tax returns. **PM**



CRACKING THE CODE

Upgrade and Save

TAX CREDIT UP TO $1500 — *30 percent of cost through 2010*

Window, door replacement	>>> Must have a U-factor and solar-heat-gain coefficient (SHGC) of .30 or less, which is a more stringent requirement than for some Energy Star–certified products. (U-factor and SHGC express heat flow through an object, hence its insulating value.) See *garagewownow.com* for more information on which garage doors qualify for credit.
Roofing replacement	>>> All Energy Star metal and asphalt roofs qualify. Download "Find A Product" from Energy Star's Roof Products page for more information. Synthetic roofs are not covered.
Installing insulation	>>> Must last five years or have a two-year warranty. Insulated siding and cladding don't count, and it's not yet certain whether vapor retarders do. Loose fill, batts and blankets, and rigid board all qualify. It remains unclear whether spray foam and air sealing are covered, according to the EPA.
Heating and cooling systems	>>> Not all Energy Star products will qualify for the tax credit. See the Consortium for Energy Efficiency product directory for qualified types of central a/c and air-source heat pumps. Consult the Gas Appliance Manufacturing Association for natural-gas- and oil-using heating products. Check *pelletheat.org* for information on biomass stoves.
Water heater replacement	>>> Some Energy Star–qualified gas storage and gas-condensing water heaters will not be eligible for the tax credit. See "Residential Water Heaters Key Product Criteria" under Energy Star's Products tab.

TAX CREDIT $1500 + — *30 percent of cost and installation through 2016*

Geothermal heat pump	>>> All Energy Star geothermal heat pumps, which use about 30 percent less energy than standard pumps, qualify.
Solar water heater	>>> All Energy Star solar water heaters qualify for the tax credit, but it's unclear whether using them for radiant floor heating is allowed. No dice for swimming pools or hot tubs—the water must be used in the dwelling.
Solar/ photovoltaic panels	>>> No federal restrictions on qualifying products available. Contact the Solar Energy Industries Association for further information. *(seia.org)*
Small wind-energy systems	>>> No federal restrictions on qualifying products available. Contact the American Wind Energy Association for further information. *(awea.org)*

General questions can be answered on Energy Star's "Federal Tax Credits for Energy Efficiency" Web page: *energystar.gov/index.cfm?c=products.pr_tax_credits.*

ILLUSTRATION BY GABRIEL SILVEIRA

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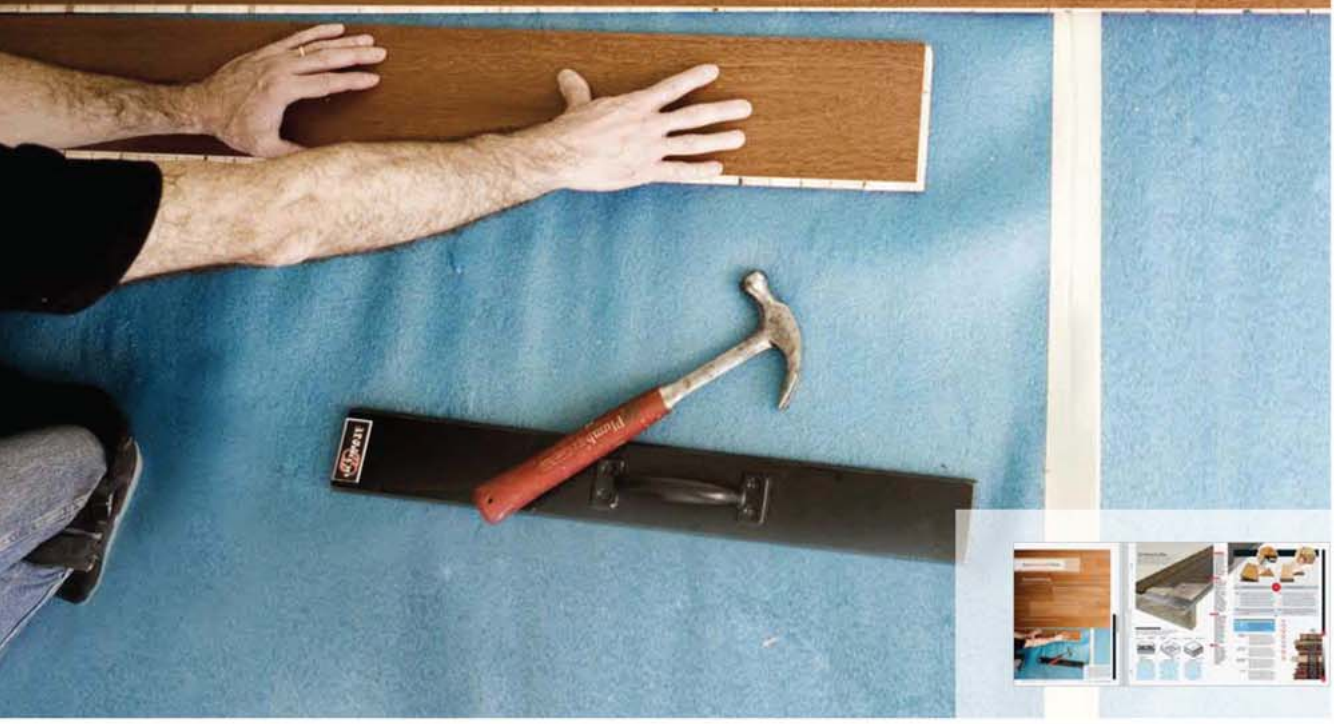
Down With Flooring

MODERN FLOORING CONTAINS MORE THAN MEETS THE SHOE. HERE'S A LOOK AT HOW SCIENCE IS CHANGING THE WAY WE WALK THE PLANKS.

Hammering down a traditional hardwood floor feels a lot like bludgeoning a jigsaw puzzle: Spread out the pieces, slip in the short planks and stagger the edges. Slide over the crescent-shaped nail gun, wedge one plank's tongue into the next one's groove, then bang! Whack the gun with a rubber mallet to fire off a nail, putting the next piece in its place.

But today homeowners rarely know the Thor-like brutality of the flooring nailer. They don't have to—new engineered floating systems snap together tool-free, held down by a perfect fit within the room's walls. The simpler installation belies increased complexity in the materials beneath the floor's surface. Efficient new systems, such as vapor barriers to reduce moisture infiltration and plumbing for cozy radiant heating, install more easily under engineered planks. And, yet, despite the technical advances, many homeowners still prefer the durability and warmth of wood—not to mention the thrill of installation.

by HARRY SAWYERS photograph by SCOTT JONES



GATEFOLD PULLOUT

The Bones of a Floor

THE OBJECTIVES OF WOOD-FLOOR R&D HAVE NEVER WAVERED: STAY FLAT AND DON'T SCRATCH. ADVANCES IN FLOORING TECHNOLOGY HAVE FINALLY LEVELED THE FIELD. HERE'S A LOOK AT PAST AND PRESENT.



Traditional wood

The best value for the money over the long term: ¾-inch planks can be sanded and refinished half a dozen times, compared to three or fewer for engineered and zero for laminate. Moisture can cause problems.

Laminate

A laminate board's solid, high-density fiberboard core rests beneath a skin printed with woodgrain or another pattern. Some laminates resist kitchen stains and traffic better than engineered and wood floors. For high durability, look for an abrasion class (AC) rating of 3.

Engineered

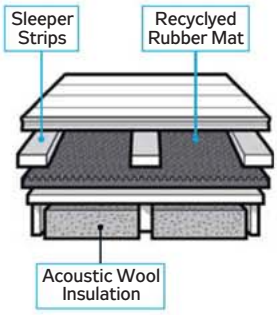
Built with a plywood core and a hardwood wear layer, engineered floors vary in thickness from ⅜ to ¾ inch. Fatter floors last longest—pros can remove a layer as thin as a business card when refinishing, but the finest engineered floors have no more than a 3- to 5-mm wear layer. Look for a five- to seven-ply body and a long warranty.

Subfloor

Joists, covered by ¾-inch plywood, ideally run perpendicular to flooring. When they are parallel, pros double the plywood and add blocking every 24 inches.

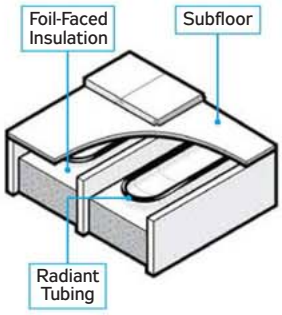
EXCEPTIONAL FLOORING

Special circumstances require adjustments below the finished floor. Here's how installers handle unusual situations.



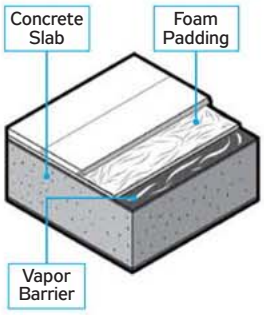
SOUND PROOFING

Mass-loaded vinyl barriers were once the best way to muffle noise, but now builders use recycled rubber mats to reduce sound transmission and resist impact. Wood flooring and canned fixtures overhead transmit noise readily. A floating cork floor or carpet has a better chance of achieving the sound of silence.



RADIANT HEAT

Pros mount radiant tubing below the subfloor using heat-transfer plates or brackets, or simply by stapling it up from below. PEX tubing is standard, but newer EPDM rubber hoses such as Onyx's are more conductive and durable. Engineered or floating floors expand and contract less than solid wood.



CONCRETE

Installing nail-down flooring on a slab requires sleeper strips to give the nails material to bite. It's labor-intensive, so floating floors are more common than hardwood. Nail-free floaters won't damage the vapor barriers that defend against below-grade moisture infiltration.

ILLUSTRATION BY **GORDON CHAPMAN**

STUDIO CATASTROPHIC FX; ILLUSTRATION BY GABRIEL SILVEIRA (FLOORING INSETS); PHOTOGRAPHS BY JEFF WESTBROOK/STUDIO D (FLOORING)



Floating Click-Together >> VS. << Nail-Down Tongue-and-Groove

Pros: No nail guns needed. Easy to install on concrete slabs. Conceals slightly uneven subfloors. Won't puncture vapor barriers. Swells like cardboard when wet, then reverts to original shape. Soft underfoot. Prefinished and ready for use—convenient when redoing a single room (but ongoing construction can damage the new floor's finish).

Cons: Tricky to lay out. Uniform pieces don't make random patterns. Installation requires repeated cuts to fit around a room's perimeter.

Pros: Staggered plank lengths save installation time—pros lay out entire rooms by fitting short pieces into small spaces, minimizing cuts. Planks are available unfinished—best for ongoing construction in a gut renovation, because the finish can be applied once the work is complete. Repeated refinishing offers a longer life span.

Cons: Moisture changes can cause permanent cupping. Over concrete slabs, floors need a labor-intensive sleeper system.

Floor Finishes

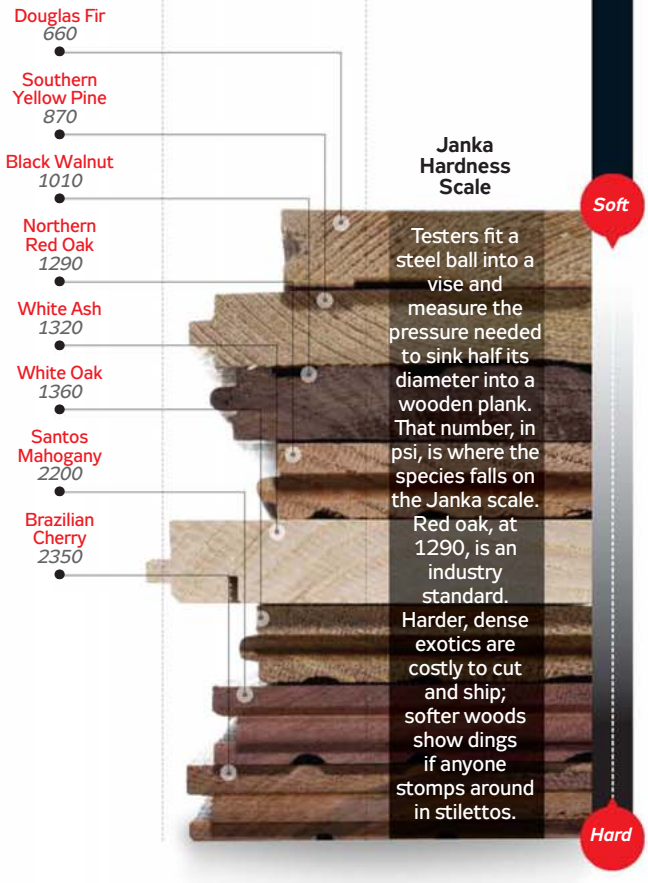
EVEN IF YOU NEVER INSTALL A NEW FLOOR, AT SOME POINT YOU'LL PROBABLY REFINISH AN OLD ONE. HERE'S HOW TO KNOW WHAT OOZE TO USE.

Prefinished Hardwood Manufacturers add aluminum oxide hardeners to polyurethane resins to strengthen prefinished flooring to levels unattainable outside a factory. Available in both engineered and solid styles. Not all are equal; warranty lengths truly reflect quality. Best for DIY installations.

Oil-Based Polyurethane Causes fumes, but it's the strongest finish pros can apply on-site. Glossy coats make a hard shell but scratch more easily than matte finishes. Two layers of high-gloss and a third of satin keep the protection but tone down the top layer.

Water-Based Polyurethane Marketed as an alternative to noxious, volatile organic compounds, water-based finishes have proven less durable than their oil-based brethren. Some installers expect three to nine years from this finish. (Oil-based finishes last six to 12.)

Tung Oil Tung oil does not form a film over a floor's surface (film-forming poly finishes seal wood shut). Applying oil to conceal scratches is required maintenance, but regular touchups mean there's never a need to sand and refinish the whole floor.





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Homeowners Clinic

by Roy Berendsohn

Q+A



The simplest water-harvesting system is no more than a single barrel equipped with a valve for a garden hose.

Harvesting Rainwater

Q After the water shortages we had last summer, we're wondering about installing a rain barrel. They seem like a great idea, but do they really pay?

A Using rain barrels is an old concept that has come around again, and with good reason. Water that washes off your roof does nothing but over-water lawn areas near the downspouts, or burden a house's foundation drain system. It also contributes to runoff that carries pollutants into waterways. Why not capture it instead, and put it to work watering vegetables or flowers?

But does it pay? Yes, in terms of environmental stewardship. No, on purely economic grounds. Unless you get a free or low-cost recycled food barrel and fit it with inexpensive plumbing parts, a pair of commercial rain barrels, diverters and perhaps even a pump will cost $300 to $700, depending on the model you choose. They will return somewhere from $3 to about $12 a year in water-cost savings, or maybe a few dollars in electricity savings if you pump water from a well.

These products make more sense in terms of water conservation and reducing polluted runoff. Say you have 1900 square feet of roof surface, not an unusual roof size. That surface will shed somewhere between 12,000 and 24,000 gallons a year, depending on how much precipitation your area receives (a large part of the continental U.S. receives up to 40 inches of precipitation yearly; arid regions may receive less than half

PHOTOGRAPH BY **DAN CHAVKIN**

that). To put that in perspective, a typical 25-foot, round, aboveground swimming pool is filled to the rim of its 52-inch depth with about 15,000 gallons. Not all of that water falls when you need it, but if a quarter of it does, that's still enough to satisfy a large part of your irrigation needs.

Before installing any system, check with your local building department about what is permitted where you live. Many states have laws that govern rainwater harvesting, even on a small-scale, individual level. Alaska, Arizona, California, Colorado, Idaho, Montana, New Mexico, Oregon, Utah and Wyoming have regions that restrict the practice or require you to file a permit and prove that you're putting the captured water to beneficial use. On the other hand, some states and municipalities encourage the practice by subsidizing rain barrels or providing guidance through websites.

For people who don't want to rig up their own system, new rain-harvesting products are attractive and well-thought-out (for example, *fiskars.com*). It's not the old, half-rotted steel barrel filled to overflowing and swarming with mosquito larvae. Any system should divert the rainwater once the barrel is full. Otherwise the water backs up the downspout to the gutter and overflows. Also, if the barrel is elevated to provide gravity flow, it must be securely fastened so that it cannot tip over and hurt a child. The more thought you give to the system's design before you begin, the better it will work.

KNOW YOUR STUFF

Painter's Knives



	CHISEL-EDGE PUTTY KNIFE	FLEXIBLE 4-INCH KNIFE	PAINTER'S TOOL	DISPOSABLE KNIFE
BEST FOR	Scraping loose paint, lifting small pieces of wallpaper, removing crumbling window putty, decal removal.	Spreading drywall compound, patching cracks, light scraping.	Cleaning excess paint off rollers, scraping paint and raking failed caulk out of siding and trim or weeds from sidewalk control joints.	Touching up putty or drywall compound on painted surfaces without leaving scuff marks.
DETAILS	Tool has a thick (5⁄64-inch) high-carbon steel blade with an edge ground to a chisel-shaped bevel.	Blade is 1⁄32-inch-thick high-carbon steel. Better models are more abuse-tolerant; they are constructed so that the blade tang runs the length of the handle. *hydetools.com*	A jack-of-all-trades tool with a 5⁄64-inch-thick blade. Some models have a metal cap on the end of the handle for bumping in loose drywall nails.	Blade is made from flexible polystyrene. Bending it after putty or filler has dried is often enough to crack off and remove hardened goo, prolonging the tool's use.

PHOTOGRAPH BY JEFF WESTBROOK/STUDIO D

Mouse House

Our 10-year-old brick ranch house has mice. I found a gap under the fascia where they were coming in, and I sealed that. I also cut back tree limbs that might have allowed them to climb in. I want to find and seal other entries. Any suggestions?

I'm no pest-control contractor, but I've seen mice squeeze through incredibly small openings, and I've seen their droppings around a variety of impossibly small entries: the perimeter gap around dryer vents, the exterior vent for central vacuum systems, the opening between a garage door weatherstrip and the doorjamb, and through foundation vents. One of the best ways to check for mouse entry points is to turn on all interior house lights at night, including those in the attic and crawlspace. Then, with all windows and doors shut, walk the perimeter of the house. Where light peeks out, mice can sneak in.

Old-Trellis Rehab

We had a fine old trellis on the side of our house that rotted apart, caved in and damaged the climbing rose on it. The steel nails driven into our house's brickwork were mostly rusted away as well. Where do we start this repair? Should we call a mason?

First, prune away any damage to the rose. When you're finished, there shouldn't be any ragged stumps or twisted canes. Next, salvage what you can of the old trellis, not for use, but to help you design its replacement, which should be built out of cypress, cedar or pressure-treated lumber cut into slats on a table saw. Fasten all parts, using hot-dipped galvanized nails or stainless-steel nails and screws.

You mentioned that the original nails driven into the mortar (or the brick) had rusted through. That's bad.

Get up on a ladder and inspect those spots. Rusting steel expands with enough force to crack bricks and mortar, and this will need to be repaired. Unless the damage to the brick and mortar looks severe, you probably won't need a mason. Pull out any remaining rusty nail stubs.

Now the challenge is to attach the trellis so that corrosion won't damage the wall. To fasten the new trellis, use stainless-steel Tapcon masonry screws or Zamac Nailin fasteners, also known informally as mortar plugs. The latter is a two-part fastener consisting of a nail and a body of Zamac alloy—a corrosion-resistant metal formed from zinc, aluminum, magnesium and copper. To install this fastener, use a hammer drill and a masonry bit or the new Bosch multipurpose bit, and bore through the lattice into the bricks or mortar behind it. You blow the hole clean, then hammer the Nailin through the lattice. The head on the Nailin body holds the lattice firmly in place as the steel nail expands the body, firmly wedging the lattice to the masonry. There are different types of this fastener. Make sure to use the one with the mushroom head and a stainless-steel nail. The carbon-steel nail version will rust.

Septic Seminar

How often do we need to pump our septic tank? We've had advice that ranges from one year to five.

I'm just glad you didn't ask me the "dead chicken question." It goes like this: "If I regularly toss a whole dead chicken into my septic tank, will that reduce or even eliminate the need to pump the tank?" We used to be asked that question quite frequently. The thinking was that the bacterial activity created by the chicken carcass was so great that it reduced or eliminated the need to pump sludge and scum from the tank. There are still people who fervently believe in the chicken hypothesis, swearing that they haven't had to pump their tank in years, if ever. Really, all that these people are doing is contributing to groundwater pollution by sending bacteria-laden filth out of an overburdened tank into the system's leaching field (the buried pipes that receive the outflow from the septic tank). I'm thankful that interest in the technique seems to be dying off.

So to answer your question, the average system should be inspected yearly and pumped every three to five years. But to get more specific, you'll need the advice of a septic tank pumping company (and most are honest, in my experience). You can tell whether any service provider is trustworthy by subjecting his advice to common sense. In this case, the specific pumping interval would obviously depend on how big the tank is and how many people live in the house. And while you're searching, drop by the website of the National Environmental Services Center, operated by West Virginia University. It has a wealth of information on maintaining residential septic systems, dead chickens excluded.

Icemaker Iced

I had to shut water off at the kitchen sink for a couple of days while I went about some plumbing and remodeling. After restoring water, I find that the refrigerator's icemaker isn't working, but water is getting through the icemaker's inlet valve.

I suspect that loosened sediment from the plumbing work has clogged the icemaker, so I ran this idea past Chris Hall, a former appliance technician and now president of *repairclinic.com,* an appliance parts provider. He had an even simpler diagnosis: "My guess is that the fill tube at



the top of the refrigerator is frozen solid," Hall says. "Thaw the tube with a hair dryer."

Hall recommends that after thawing the tube, check whether the icemaker's water-inlet valve is stuck open, allowing a small drip to continually feed the icemaker. If you find dripping, it indicates that sediment may be preventing the valve from closing, and this could cause the problem. If so, replace the valve. It can't be repaired.

Bulb Knocks Out Circuit

When a light bulb burned out in a bedroom ceiling fixture it knocked out the circuit breaker that serves that room. We changed the bulb and switched the circuit breaker back on, and everything seems fine. It's a relatively new home. Should we call an electrician?

You probably don't have to call an electrician unless you see repeated circuit breaker tripping. Having seen the same thing happen, I've wondered why, so I checked with Bill Lego, a PM contributor and electrician in Rockford, Ill. "Sometimes a light bulb fails in supernova fashion, flashing a big arc," Lego says. "I suspect that the filament's failure permits a boatload of current to flow through the arc plasma. This surge of current exceeds the circuit breaker's rating, causing it to trip." It's a plausible, physics-based theory.

Flaking Latex

We painted some rooms recently with latex paint and are disappointed to find that some of the new paint is flaking off the walls and ceiling. Please help.

To bond properly, latex paint requires a clean, slightly rough surface. I'm willing to bet that the problem areas are in the kitchen and bathroom, because those walls often have a film of dust, grease or mildew. Also, there could be a moisture source that's contributing to the problem. Assuming that there aren't stains on a ceiling, which would indicate a leak through a roof or skylight, sometimes a bathroom fan discharges into the attic, and the resulting humidity can be enough to lift paint in rooms below. If the bathroom is unvented, then the vapor pressure can be great enough to lift paint off adjacent walls.

If moisture vapor isn't the culprit, scrape the flaking paint off. Then thoroughly wash the surface with a strong solution of TSP (trisodium phosphate) and hot water. Next, lightly sand the surface with a drywall sanding pole and a drywall sanding screen, or use a hand-sanding block and 220-grit paper. Thoroughly rinse the surface and wipe it clean. To check your work, press your palm against the surface. Prime the affected areas and repaint. **PM**

GOT A HOME-MAINTENANCE OR REPAIR PROBLEM? Ask Roy about it. Send your questions to ***pmhomeclinic@hearst.com*** or to Homeowners Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.

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DEGREE OF DIFFICULTY /// MODERATE

Replacing Fan Motors

BRUSH-TYPE 12-VOLT FAN MOTORS LIVE IN A HOSTILE ENVIRONMENT. WHEN THEY FAIL, IT'S USUALLY NOT A HUGE TASK TO REPLACE THEM. *BY MIKE ALLEN*



We picked up this aftermarket fan motor at an auto-parts store for $50.

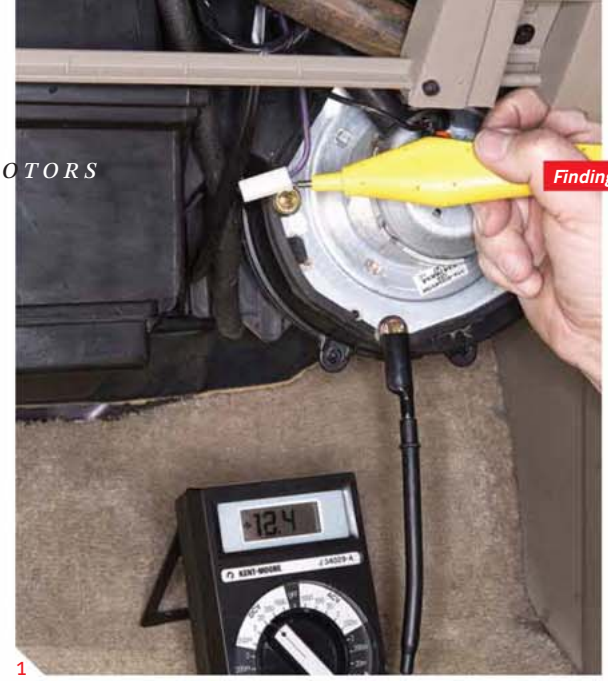


It's hot. Really hot. A wave of shimmering, sauna-hot air hits your face and takes your breath away as you open the door and settle into the car. Too bad there wasn't a tree anywhere near this steamy, black asphalt parking lot. Who would think a car's interior could get this hot?

You immediately thumb the a/c controls and wait patiently for relief. A brief moment of warm air from those vents turns the sweat beading on your forehead into crunchy little salt tattoos. Within seconds, the air begins to cool off, and so do you. Not a moment too soon.

But before you clear the parking spot, before the air inside the car even approaches acceptable temperatures—there's a funny smell. It's

PHOTOGRAPHS BY **DENNIS KLEIMAN**



1



2



3

Finding the Problem

1 If both hot and ground wires are still attached to the motor's frame, back-probe the hot wire to the motor armature with the key on and the fan-speed switch set to high. You should see full battery voltage.

2 Standing on your head with your face in the footwell isn't much fun, but you'll need to remove the motor's attachment hardware.

3 We managed to sneak this dead motor out of the plenum without removing half the dashboard. Unfortunately, they're not all this easy. Some fan motors are removed from inside the engine compartment, which, counter-intuitively, isn't necessarily easier.

sweet and acrid. The smell builds for a minute or two and then the fan slows and the cool breeze dwindles. There's a brief sizzle from under the dash, followed by an even more acrid smell. What's going on? Paradise by the dashboard vents is over. Your fan motor has died.

What Went Wrong?

Okay, not every fan motor dies in such a spectacular blaze of glory. The lives of these devices are unpredictable. Sometimes the motors just keep zipping along and lose steam gradually—until they just don't turn anymore. Or the fan may croak on the spot without warning. That's usually an indication of seized bearings. These motors generally don't use ball or needle bearings, they just glide on a simple bushing of oil-impregnated bronze. Dirt and corrosion can create so much friction inside that they'll gradually grind to a halt. So, our first step is to find out what, exactly, went wrong.

Start by checking the fuse. The condition of the fuse really won't tell you what the problem is—but stay tuned. If it's blown, don't replace it now, because there's a good chance the new one may blow immediately too.

Next step? Find the fan underneath the dashboard and spin it manually. This process might involve temporarily removing a duct if you have a cabin air filter. If the fan spins readily, the problem is usually electrical. If it feels sticky, or has rough spots as you turn it, just go out and buy a new one right now. It's done.

Fuse okay? Fan spins smoothly? Get out the meter, or at least a test light. It's time to chase voltages.

Basics First

Twist the ignition key to accessory (ACC) mode and turn the fan switch to high. Back-probe the hot line into the fan, and you should see 12 volts in the system. While you're poking around, be sure both the hot and ground wires are still attached. It's not impossible for these wires to be knocked loose by the errant toe of a boot or a suicidal Barbie doll lurking on the floor.

Check the schematic—a few vehicles switch from the ground side of the fan motor, not the high side. If so, there should be 12 volts to the motor full-time, regardless of the switch position, and you'll need to check voltage on the ground side. If you have no juice to the motor, it's time to find out why.

Fusable Link

Sometimes the problem is not the motor itself. It's the resistor. A fan constantly turning full-chat is noisy, and unnecessary a lot of the time. So most fan blower switches use a voltage-dropping resistor assembly to slow down that motor to a quieter speed. When this resistor dies, the fan will no longer work at certain speeds. The resistor was blown on our test car—we knew that for certain because the voltage was only meterable at the motor's hot terminal with the switch set to high. We replaced the resistor block before doing any further diagnosis. These resistors generate a lot of heat, so they're typically mounted inside the plenum, right in the path of airflow from the fan. Guess what? When the fan is compromised, the resistor overheats. Consequently, it's not uncommon to see fried resistors accompanying fried blower motors. The resistor is usually inexpensive ($10 to $15) and easy to swap out. If the fan motor on my car was dead, I'd probably go ahead and change the resistor while I had my head under the dash.

With the switch on a lower setting and the motor disconnected, you'll still see a full 12 volts of system voltage at even the lowest setting. The voltage won't drop down to a lower level until the fan motor starts to draw current.

Our spent motor was completely open electrically, and wouldn't load down the circuit at all, even after we replaced the resistor. If your motor has



4



5



6

4 The new motor had to be snaked up into place past some serious roadblocks in the footwell and under the dash. Patience. Be sure not to damage the plastic fan. Some replacement motors don't come with fans—you'll need to recycle your old fan-blade assembly.

5 Good luck getting a wrench on all the fasteners without adding an extra joint in your wrist.

6 Note this deceased fan's shorted copper windings, blackened insulation and worn-out brushes and commutator. R.I.P. A dedicated motor shop could probably resuscitate it if it were rare and unobtainable.

bad bushings and still turns, albeit slowly, it probably draws enough current to cook itself from the extra drag. This extra current, you would think, would blow the fuse too. Unfortunately, there is often enough headroom in a fuse's rating to let the motor melt before the fuse pops, if it blows at all. If your fan motor is killing fuses, uprating the fuse to a higher amperage is not, I repeat, not, an acceptable solution. There's the chance of damaging not only the motor and resistor with the excess current, but also the wiring in the harness and the blower-speed switch itself. You've been warned.

Parts Chasing

We ordered a replacement blower from a website, and of course the wrong part showed up. Big surprise, eh? So we ordered another one, from a different vendor. Big surprise, Part II: It was the wrong motor, yet again. That precipitated a trip to the local auto-parts store. And as we've come to expect, the counterman was able to crack the code for our particular vehicle and come up with the right part overnight. Said part was inside an identical box, with an identical part number printed on it. Go figure. If you have a very old or odd car, you may have less luck finding a source. A dealership should be able to get anything for most late-model cars; expect to pay through the nose. If you have an older vehicle, you may need to look to the restoration market. My first source is usually J.C. Whitney (*jcwhitney.com*), or the back pages of *Hemmings Motor News* (*hemmings.com*). Last resort: junkyard parts.

If you must use an older, boneyard fan, clean and lubricate the bearings. The bearing on the fan end of the armature is accessible: Spin the armature shaft and hose it down with brake cleaner. Follow up with oil—a few drops of LPS 3 (my personal favorite) or even motor oil. The other end of the armature is usually inaccessible. You can try to disassemble the motor, but I've used this trick successfully: Drill a $^{1}/_{16}$-inch hole in the stamped-steel end cap. Put grease on the drill bit to catch any shavings. Inject a sparing amount of LPS 3 or oil into the hole. Then clean up the area with brake cleaner and seal the hole with silicone gasket sealer. Can't find even an old motor? Take the fried one to an electric motor shop. For a surprisingly small amount of money, most motors can be rebuilt. This procedure starts with disassembly and inspection of all the windings for internal shorts, opens or shorts to ground. If the windings look or test bad, they can be rewound with fresh, varnished copper wire. The shop will also true up the commutator on a lathe and undercut the copper contacts. Following that, it'll clean up and lube or replace the bushings, replace the brushes (which are usually a standard size) and button the whole thing up. Not every motor is rebuildable, but in desperate times I've pried open some crimped-shut motors that weren't designed to be repaired.

A Breath of Fresh Air

Okay, you've sourced a new, used or rebuilt fan motor. If it's not a new one, I'd recommend a test run on your workbench before going through the trouble of installing it. You can either run jumpers from the car battery or just use a battery charger or other 12-volt source. You'll need 10 amps or so to run the motor at full speed. When the jumpers make the connection, the fan will spin merrily. And since every action has an equal and opposite reaction, the motor housing will spin counter to the fan's rotation. Don't let it spin right off the counter onto the floor. Don't ask me how I know this.

Installation is the reverse of removal. Reinstall any cooling ducts, and keep the wiring harness away from the fan blades. If your old motor came with any sound insulation, replace that too. Don't use duct tape to hold the insulation back on—the extreme underdash temperatures will dry it out within months. If you must, glue the insulation back with RTV (room-temperature-vulcanizing) silicone gasket sealer. **PM**

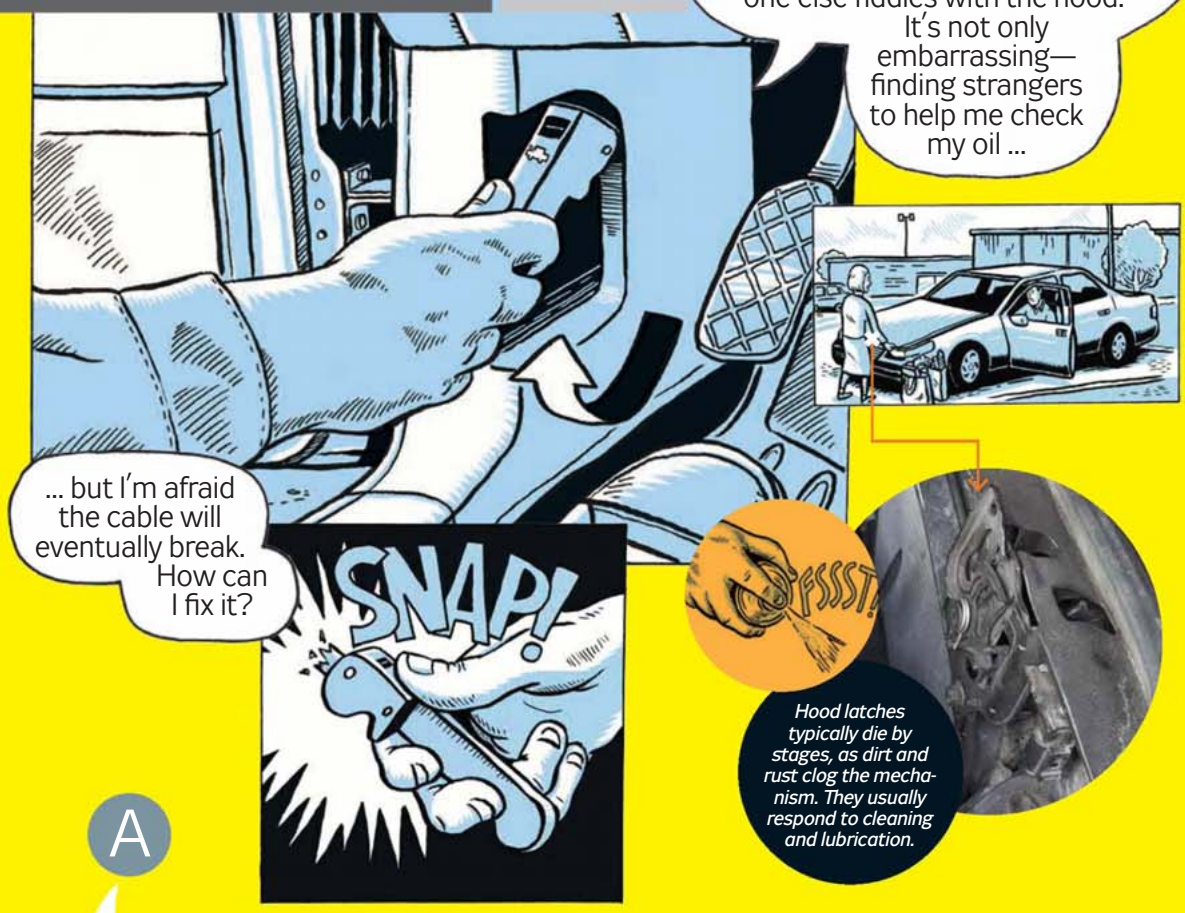
Car Clinic

by Mike Allen

Q+A

Open-and-Shut Case

Q I can't open my car's hood unless I pull on the release while someone else fiddles with the hood. It's not only embarrassing—finding strangers to help me check my oil ... ... but I'm afraid the cable will eventually break. How can I fix it?



Hood latches typically die by stages, as dirt and rust clog the mechanism. They usually respond to cleaning and lubrication.

A

My trick to opening a stuck hood? Pull on the hood-release handle with your right hand while standing outside the open car door and slapping the hood, hard, with an open-palmed left hand. Oh, yeah, it stings, but at least the hood pops open.

You're right; eventually, the cable will stretch or break, and you'll just have to sell the car. Of course, I jest. Actually, this is a common complaint, and it's almost always caused by a dirty, under-lubricated or rusty hood-latch mechanism. Start by opening the hood—somehow. Now use an aerosol can of carb cleaner to clean the mechanism. Wear eye protection to keep the hydrocarbon cleaner from splashing back into your peepers (don't ask). Keep a shop towel handy to catch the drips and overspray. When the droplets begin to run clear, wait a few minutes for the cleaner to soak in, and do it all again. Now is the time to check that the mechanism isn't binding because it's out of alignment. Were you in a fender-bender last spring? That accident could have misaligned your hood. The latch assembly is probably bolted to the radiator core support, and might even be adjustable. Don't, I repeat, do not, adjust the latch assembly unless you have good reason to believe it's been disturbed.

Get Saturday Mechanic Jr. to work the hood-release handle while you watch the latch from underhood. If it seems like it's not moving the pawl in the latch far enough to completely disengage, adjust the cable. Don't choke up on the cable so far that the latch runs out of travel before the handle does. If you have your helper hold the handle all the way open and clamp the cable down, you'll be fine. If you make it too tight, you'll break the cable (don't ask, Part II). Now, douse the latch mechanism with some aerosol grease. Don't use silicone or penetrating oil, but motorcycle or bicycle chain lube is fine. You should use a lubricant that

PHOTOGRAPH BY DENNIS KLEIMAN

ILLUSTRATIONS BY **LED PENCILS**

leaves a film of grease behind. If you think you need to lubricate the handle under the dash, use silicone spray to keep grease off both the carpet and your hands. Don't use silicone underhood. It's just too thin to stay put out in the weather, and potentially could contaminate the oxygen sensor.

Underhood Turbulence

My wife has a 1990 Lincoln Town Car, which she loves. Recently we've noticed an engine vibration you can feel in the gas pedal. Yet it goes away when we're parked. Is this an engine problem or a transmission problem?
Probably neither. If you're feeling the shake through the accelerator pedal and not through the steering wheel or the car's body, then I'd hazard a guess that a motor mount is broken or loose. This will allow the engine to shift under acceleration. When the engine's torque is just right, the mount lifts away from the frame. Feather the throttle just a bit, and the engine's weight holds the mount down. But too much throttle and the motor mount will top out, and things are free to shake. The shaking is then transmitted to your right foot through the accelerator cable. Time to replace that broken mount.

Shiftless

I have a tough transmission question for you. My '93 Mustang GT sometimes won't go into gear. If I'm sitting at a traffic light in neutral with the clutch pedal released, then push the clutch in to put it in gear, the shifter won't go into that gear (or any gear) until I wait to the count of three. At that point, it will go in and out easily—until I let the clutch out with the transmission in neutral again. The clutch cable is adjusted correctly, and I have no problems shifting once the car is moving. I can't figure this one out, and I'm a professional mechanic (albeit for Benz, so we only see maybe a dozen manual trans cars in a career). It's really stumped me and my co-workers; any ideas?
Sounds perfectly normal to me. You've got a clutch disc, input shaft and the front half of the transmission spinning along merrily at idle speed, driven by the flywheel and pressure plate. When you step on the clutch pedal, that rotating mass doesn't stop spinning instantly. It takes a second or three to slow down. The 1-2 dog ring in the transmission won't mesh with the first-gear engagement ring until it's nearly stopped. The synchronizers use friction to slow down (or speed up when downshifting) all the whirly bits to allow gear changes. That resistance you feel in the shifter is the synchronizer matching speeds. When that synchro starts to wear out, you'll get a crunching noise.

Best practice is to always depress the clutch a few seconds before trying to shift into first gear. This will let the parts slow down on their own.



Scan tools have become almost generic. Simple code readers cost around $50, and more capable scan tools run $200 and up. Unfortunately, many of these devices won't interface with the ABS systems on most cars. Until now, you've had to visit a dealer with the appropriate factory ABS scan tool for diagnosis—or even to perform a proper brake bleeding. Enter the $460 Innova 3160, which is ABS-capable on many 1996-to-current domestic vehicles. *innova.com*

Dead Mule

I have a 2006 Kawasaki Mule 610. This winter it just wouldn't start—no matter what I tried—choking, no-throttle, quarter-throttle or full-throttle. The battery had enough juice to turn it over, but there was no spark (sometimes just a *ppfst, ppfst, ppfst* sound). A Kawasaki mechanic told me another spark plug should work. He said, "If it gets flooded, that will ruin the spark plug. It takes a new one to allow the engine to turn over. Just cleaning the old spark plug won't do it." How can flooding an engine permanently ruin a spark plug?
When the choke is on, especially when air temps are low, the fuel going into the cylinder tends to remain liquid rather than evaporating, wetting the plug's insulator with fuel. Only fuel that's evaporated and mixed with intake air will burn. After the engine starts and warms up, the fuel gets atomized much more completely—no

PHOTOGRAPH BY DENNIS KLEIMAN

problem. But until then, all that liquid fuel just soaks everything. The little combustion that actually happens is incomplete and will plate the entire inside of the combustion chamber, including the plug, with a sloppy film of gasoline and carbon and moisture—which is conductive enough to let the spark trickle down the side of the insulator instead of jumping the 0.028 of an inch to the ground electrode and lighting the charge that comes in on the next intake stroke. Continued cranking and partial combustion just makes it worse.

A fresh plug fixes that. As far as your mechanic's assertion that the plug will never work again, he's partially right. The oxides and carbon can't really be removed, unless you use a spark plug cleaning tool. I have one. And I've have had it for 35 years. It's just a small sandblaster (although I fill mine with glass beads) that scrubs away all the goop. Problem is, it also rounds off the edges of the positive and ground electrodes, and those work best when the edges are sharp, not rounded. The electrons in the spark like to jump off pointy things, not rounded ones. When plugs had steel electrodes, I used a file to dress the electrodes and then gapped them back to the correct gap. Modern plugs mostly use precious-metal electrodes that don't take kindly to that. I haven't gapped a plug in a new car for years.

I've had engines in motorcycles and cars and power equipment that would consistently take two sets of plugs to get started on cold days. I'd pop in a fresh set to light the fires, warm up the engine, and then put the originals back for the rest of the day. Of course, I had less money and more time back then. Ignition systems are a lot better than they used to be, but sometimes not good enough.

Synthetic Leakage?

I heard from several "not too reliable" sources that once you use synthetic oil in your crankcase, you



should never change back to regular motor oil. I have difficulty believing that, but would appreciate your response.

A generation ago, when synthetics first hit the market, there were a lot of complaints about leaky engines. In spite of claims to the contrary by the purveyors of these new, premium oils, they didn't have the same seal-swell characteristics as mineral oils. Mineral oils generally have an additive package that makes rubber and cork seals swell up slightly, promoting a tight, oil-free engine. When you switched to synthetics, the seals would shrink, ever so slightly, and oil would weep. Exacerbating this condition, the synthetics were generally much thinner in viscosity, and would find smaller gaps to percolate through. The result? Speckles on the driveway. Other brands of mineral oil had less seal-swell. These engines didn't leak when filled with synthetic—but the seals and gaskets compressed and wore out in their swollen state. Change back to low-swell oil; the seal contracts to its former, less turgid state, and out it gushes.

Fortunately, the petroleum industry seems to have a better handle on that today. Don't worry. Change back and forth as you deem necessary. **PM**

GOT A CAR PROBLEM?
Ask Mike about it.
Send your questions to ***pmautoclinic@hearst.com*** or to Car Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.

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FROM FLOATING MP3S TO LIFE-SIZE Wii, BRINGING YOUR ELECTRONICS OUTDOORS OPENS UP A WORLD OF NEW POSSIBILITIES.

BY GLENN DERENE

Ah, summertime. The weather is warm, the grass green. It's time to turn off the surround sound, put down the video-game controller and head outside, right? Well, let's hold on just a second. I'm a big fan of fresh air, but must we leave all our music, movies and video games inside? I say, absolutely not! The back lawn is as conducive to high-tech fun as the living room.

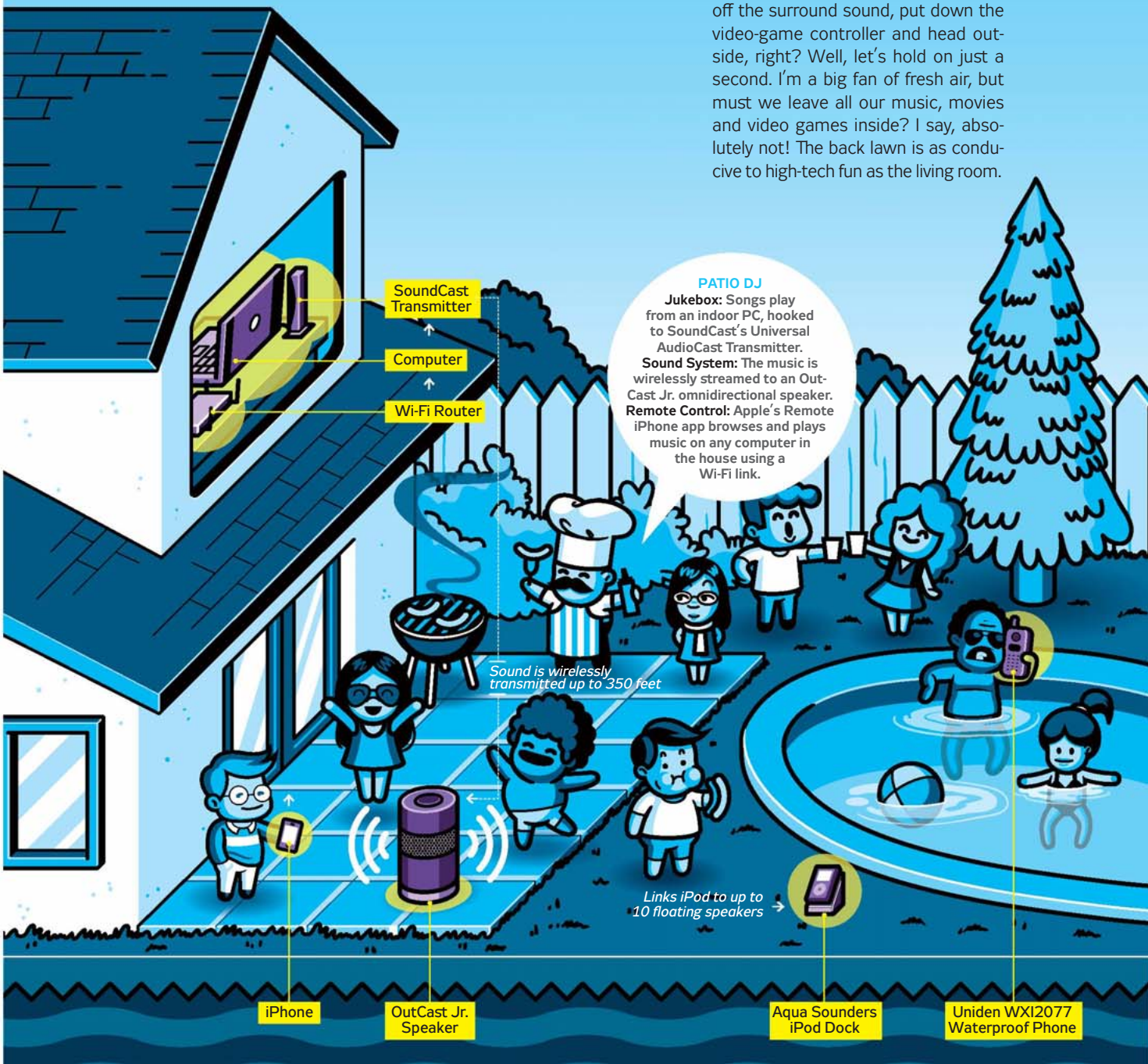


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Patio DJ

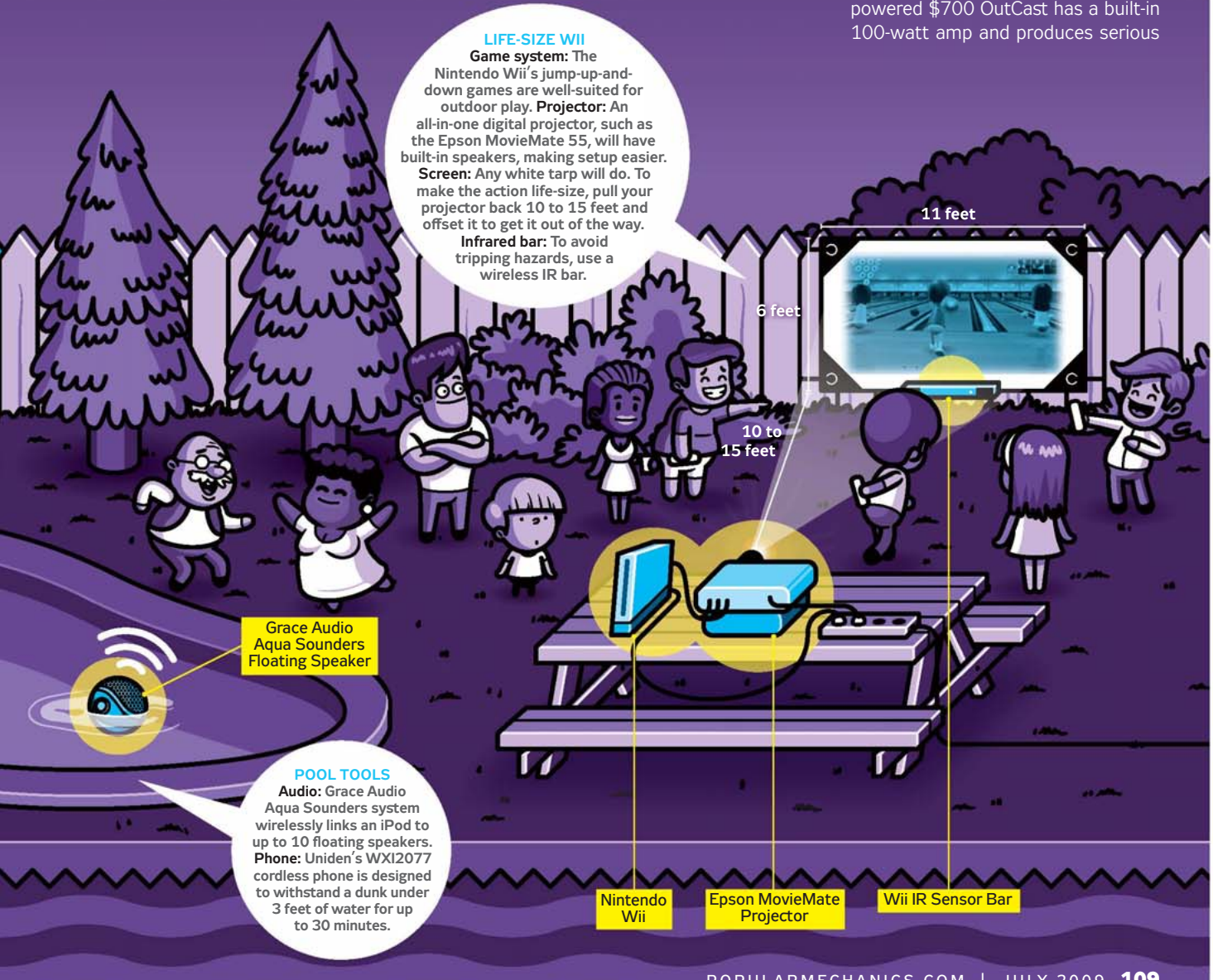
Consider that quintessential warm-weather hearth, the barbecue. What better way to complement the sounds of chatting friends and sizzling burgers than with a playlist of hot tunes?

Traditionally, outdoor sound systems have fallen into two categories: First is the boombox. Nowadays, many of these portable stereos have integrated iPod docks, making them easy to use, but none could qualify as a serious sound system. A second, more labor-intensive path is to permanently wire weatherproof speakers (see "All-Weather Wiring," next page).

But in the age of wireless networking and PC-based music files, wiring outdoor speakers to a receiver that isn't necessarily anywhere near your PC seems like a complex and probably unnecessary exercise. As it turns out, there are several ways to bypass the AV receiver and throw music directly from PC to patio, and there's one simple way to control it all.

An easy, and relatively cheap, way to stream music outside is to use Apple's AirPort Express. This small, $100 device plugs into any wall socket, taps into a Wi-Fi network and has a 3.5-mm audio minijack that can output either an analog or digital optical signal. When you use Apple's AirPort Utility software, your computer sets up AirPort Express units on your network, and then any speakers attached to them show up in iTunes. The AirPort Express's audio output is unpowered, however, so the speakers you hook up should have internal amplifiers. (Most computer speakers qualify.)

Any AirPort Express setup will need to be temporary, however, since the device is by no means weatherproof. (For that matter, neither are most computer speakers.) Some wireless speakers, however, are specifically designed to withstand the elements. Acoustic Research has a variety of speakers that can run on a handful of AA batteries and link via radio frequency to an analog input up to 150 to 200 feet away, depending on the model. But by far the most impressive outdoor sound system I've tried is the OutCast omnidirectional wireless speaker from SoundCast. The battery-powered $700 OutCast has a built-in 100-watt amp and produces serious



bass with an 8-inch woofer (its smaller, cheaper sibling, the $500 OutCast Jr., has a 60-watt amp). Instead of Wi-Fi, the OutCast uses a spread-spectrum proprietary 2.4-GHz wireless connection to either a $100 iPod dock or a $100 Universal AudioCast Transmitter, which attaches to a computer by tapping into Windows' or Mac OS's built-in USB speaker interface.

To control it all, try Apple's free Remote app—a program so cool it single-handedly justifies the purchase of the iPod Touch or iPhone that it runs on. Remote uses the Wi-Fi antenna in either device to tap into the iTunes libraries on any computer hooked up to your network. Used with a wireless speaker setup, Remote allows you to browse all the music on your computer and DJ your tunes from your handheld device without ever going inside.

Pool Tools

Okay, weatherproof speakers will withstand rain, but what about a dunk in the pool? Call them novelties if you like, but there are wireless speakers designed to float on the surface of the water. The Aqua Sounders system, from Grace Audio, will transmit audio from a base station to up to 10 battery-powered speakers. The sound quality from these audio balls is barely acceptable (underwater, you can hardly hear them), plus they are conspicuously solid enough to provide a conk on the noggin to anyone unwise enough to cannonball into them. Nevertheless, there is something uniquely appealing about the pool-party atmosphere these things instantly create.

Far more functional is Uniden's totally waterproof WXI2077 Series cordless phone. In the days of data-optimized cellular smartphones, ordinary cordless handsets may seem passé, but just try doing laps with a BlackBerry clipped to your swimsuit. The WXI2077 floats, so you don't even have to get out of the pool to answer it, plus it uses the relatively uncongested 1.9-GHz bandwidth, so it won't interfere with Wi-Fi networks.

KNOW YOUR STUFF

All-Weather Wiring



Despite all the newfangled wireless speakers on the market, the majority of outdoor speakers get their signal and power the old-fashioned way—through speaker wire. Weather-resistant patio and garden speakers are available from many major manufacturers, including Bose (the Free Space 51 is pictured above), Polk Audio and JBL. If you are powering only two outdoor speakers and have available speaker outputs, you can hook them up directly to your home theater receiver. Otherwise, a separate amplifier is needed.

To get your audio signal from the inside to the outside, you either need to tuck your wires under a closed window or drill a hole in your house. If you do the latter, make sure you seal it appropriately with silicone on the outside. Use outdoor-rated speaker wire for all exterior speaker wiring. For garden speakers with long cable runs, consider burying PVC conduit, then joining wires with direct-burial wire connectors. (Wires and accessories are available through online retailers such as *outdoorspeakerdepot.com* and *ticcorp.com*.)

Patio speakers are more likely to be connected via exposed terminals. To prevent water from getting into exposed speaker wire, it helps to dab a bit of silicone around the connection to seal it.

Remember to position the speakers in your yard with the same care you would take when positioning them in your living room. Leave enough in-between space for proper stereo separation, and face speakers inwards toward your desired sweet spot. — *G.D.*

Life-Size Wii

The same home theater projector that can turn a living room into an at-home cineplex can also turn your backyard into a drive-in. And bringing movie time outdoors is made simple with all-in-one projectors such as the Epson MovieMate series and the Optoma DV11. These projectors have built-in DVD players and speakers, so the only connection needed to set up an instant lawn theater is an electrical extension cord.

If you like your outdoor video entertainment a bit more active, any projector with composite video and RCA audio inputs can easily be hooked up to the Nintendo Wii gaming system, throwing human-size characters on any available projection surface. For the standard-def Wii, no fancy screens are necessary—an ordinary white tarp will do. To ensure a 6-foot-tall image, you'll want a tarp measuring at least 11 x 6 feet (for a 16:9 aspect ratio) or 8 x 6 feet (for 4:3 aspect). Tie the ends to trees or use spring clamps to attach your tarp to a fence. Keep in mind that the Wii needs an infrared-light-sensor bar placed at the bottom or top of the screen to work properly, and the wire for the Wii's IR bar is 11 feet long, which can restrict the placement of the Wii and, consequently, the projector. In my experience, you want to get your projector back a good 10 to 15 feet to ensure a large enough image. That's doable with the existing wire, but you can avoid a lot of potential trips and tangles with a wireless IR bar accessory from Nyko ($20). Also, you'll want to offset the projector to get it out of your way and avoid playing against your shadow. Most projectors have dials that allow you to correct the keystone effect you get when projecting from an angle. Once you're all set up, you and your friends can swing your Wiimotes to your hearts' content while racking up strikes in your virtual open-air bowling alley. **PM**

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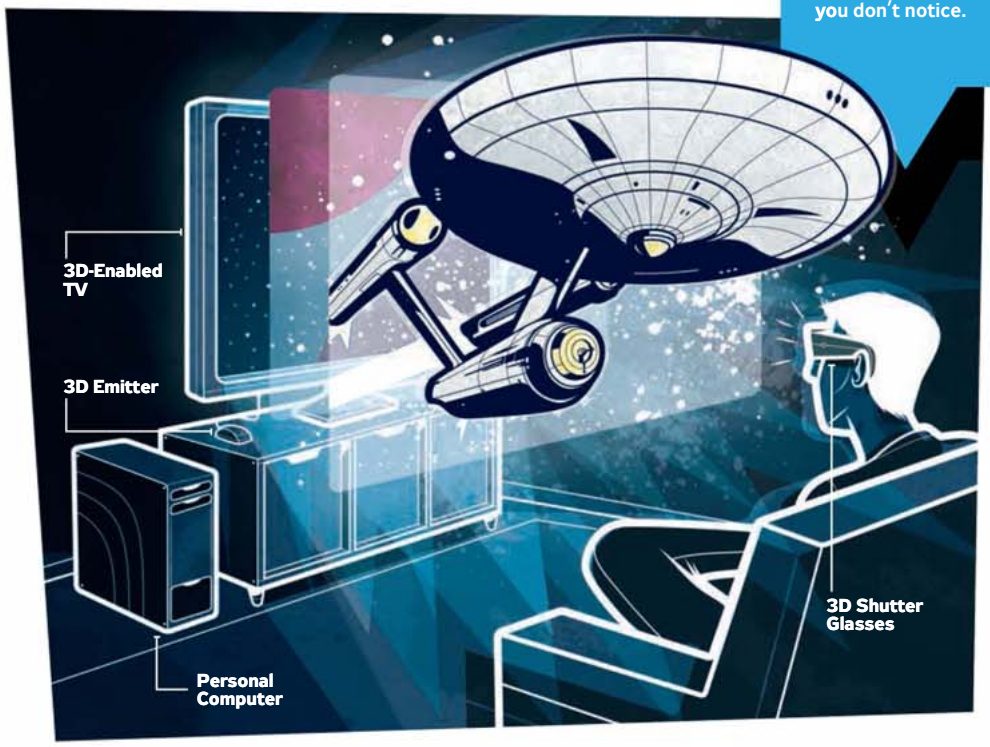
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Digital Clinic

by Seth Porges

Q+A



How It Works: 3D Shutter Glasses

A 3D-enabled TV switches between two different images 120 times per second. To deliver the images to separate eyes, the lenses black out 60 times per second at alternating intervals—so fast, you don't notice.



Bringing 3D Home

Q I love the new digital 3D movies that are coming to theaters. Is there any way I can watch my old two-dimensional DVDs in 3D?

A Yes, you can. In fact, it's surprisingly easy to play any old 2D DVD in 3D on your home TV. And while it won't be a *Monsters vs. Aliens*–level experience, it's a good-enough holdover until the studios get around to releasing home-3D versions of their growing catalogue of digital 3D movies.

First step: Find out if your TV is 3D-capable. Now, before you tune out—"Oh great, I have to buy an expensive new TV"—a surprising number of sets have this feature, though manufacturers rarely market it. In fact, every new DLP rear-projection TV can play 3D, and a decent number of plasmas can as well. If you've purchased an HDTV in the past few years, there's a fair chance it can play 3D. (Check the back for an output labeled "3D sync.")

If your TV is 3D-ready, you'll also need a PC and the Samsung SSG1000 3D conversion kit, which retails for $130. The kit comes with all the necessary hardware for the conversion, including a pair of 3D glasses, as well as a computer program called TriDef Media Player that can transform your video files and DVDs into 3D as they play. Since the movies will be playing from your computer, you'll need to output your PC's video to your TV using an HDMI cord. If your PC doesn't have an HDMI output, you can use its DVI jack and a DVI-to-HDMI adapter.

The 3D effect works by showing your eyes the same image from slightly different angles, creating the illusion of depth perception. In theaters, this is done with plastic polarized glasses that, when paired with 3D projectors and specially filtered movie screens, cause a different picture to pass into each eye. Since your home TV doesn't have these special lenses and filters, the home 3D kit requires a bit more technical trickery to pull off the illusion. It uses what are called

ILLUSTRATION BY **GABRIEL SILVEIRA**

shutter glasses. A 3D-enabled TV refreshes its image 120 times per second, but these battery-powered glasses effectively split the image between your eyes by blacking out each lens 60 times per second. A 3D emitter (which comes with the kit) tunes this flickering, ensuring that the lenses are open at alternating times so each eye receives different images from the screen. And it happens so fast that you can't tell it's going on.

As for the TriDef 3D conversion software, I noticed that the program seems to produce much of its 3D effect by pushing the bottom of the screen into the foreground and progressively sloping the upper part of the image into the background. "The basic assumption is that whatever is on the bottom of the screen is in front," says Douglas Hunter, vice president of licensing for Dynamic Digital Depth, the company that makes the TriDef software. "But that's just one of about 15 different things the software does in deciding the depth values for each object. It's also looking at things such as color, contrast, motion and object structure."

So what's the insta-3D experience like? It's definitely more of a fun toy than an enjoyable way to watch movies. I demoed the program on about a dozen test subjects. For the first few minutes, my subjects radiated wonder—like they were watching a moving picture or talkie for the first time. *Freaks and Geeks* in 3D! My DVD of old Residents music videos in 3D! ("Amazing!" "Wow!" "How the heck is this happening?") But the initial excitement soon subsided, and my guinea pigs inevitably asked me to turn the 3D off. ("Can we just watch the movie normally now?") Fact is, the experience is cool, and initially impressive, but it just isn't enjoyable for very long.

The main problem: A lack of subtlety. The best digital 3D movies make deliberate use of the third dimension, either by throwing stuff at the audience's face or by immersing the audience in the environment. The instant 2D-to-3D software doesn't do that. It just pops things into the foreground. Producing decent 3D footage is an art, and it's not one that a simple PC program is able to replicate on the fly. At least not yet.

What's Up, .doc?

I frequently get sent Microsoft Word files in the .docx format. But these won't open in my older version of Microsoft Word. Is there any way of opening them without buying a new copy of Word?

Yes. But first, a little background on the problem. Those old .doc Word files that you're used to have been around for years, and are used by just about everybody. There's something wonderful about this ubiquity—if you send a .doc file to someone, you are pretty much guaranteed he will be able to read it. But the format is also very old—its basic structure has remained mostly unchanged for the past two decades.

Beginning with Office 2007, Microsoft unveiled a new file format, called Open XML. This format uses the .docx extension, and is the default file format in Office 2007. These .docx files have several advantages over the old .doc files. They take up far less disc space (Microsoft claims the savings range from 25 to 50 percent), offer more security against viruses, and are less prone to being corrupted. (In .doc files, if an embedded image is corrupted, the whole file is usually ruined. Not so with .docx files.)

techterm

white space

In the days of analog TV, broadcasters were given buffers of extra bandwidth in between channels. But this extra space is unnecessary in the digital age, so the FCC recently ruled that anybody can broadcast on this white space—provided they prove it won't interfere with licensed broadcasts. This could open up a new era of open wireless standards.

However, the .docx rollout was met by a backlash. The problem: Unless they are updated, older versions of Word are unable to read the new .docx files. In fact, just about everybody I know who uses Office 2007 chooses to save documents as .doc files, despite the .docx format's technological superiority.

But there are ways around this problem. If you have an older version of Word, you can still open .docx files—just go to Microsoft's Web site and download a free update called the Microsoft Office Compatibility Pack. For Mac users, there's a similar download called Open XML Converter.

Of course, many corporate IT departments limit employees' ability to download and install new files on their computers. If you have this problem—or if you just want to open a file in a pinch—head to a Web-based file conversion site. These sites take uploaded .docx files and e-mail you back a .doc version. My favorite is *zamzar.com*. It's quick and easy, and it allows you to switch among just about every file format.

Screen Saving

My iMac has a built-in monitor. Is there a way of using this as a second screen for another computer?

When it comes to screen space, you can never go overboard. Large monitor and multiscreen setups make it easy to multitask, and have been shown by a number of studies to boost productivity. It's a shame, then, that Apple doesn't build video input jacks into its iMacs—these all-in-one computers have a built-in monitor, and it'd be nice to be able to use it with other systems. This would be particularly useful for laptop users looking for a way to expand screen space when they aren't on the road.

But even without an input jack, you can still put an iMac to work as an external monitor for another computer. You'll need a program called ScreenRecycler, which employs what is called the VNC, or Virtual Network Computing, protocol. VNC is usually used as a way to allow one computer to remotely access and control another, but ScreenRecycler uses it to turn the second computer into an adjunct monitor. Note, though, that while the second screen can come from any type of computer (even a laptop), the computer you're working on has to be a Mac. **PM**

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7 Smart places to stash your cash

Home safe sales smash 60 year records due to new banking worries

BY ROBERT ANTHONY

So you're still hiding money under the mattress or in the bread box?

Well, you're not alone. Ever since financial institutions have been dropping like flies, millions of Americans have stopped relying solely on their banks.

1. Be sure your bank is insured. If you're not sure if your bank is FDIC insured find out or get your money out. They only have enough cash on hand to cover about 2% of nationwide deposits. So it's not always wise to keep all your eggs in one basket.

2. Start and grow a coin collection. Coin collections are tangible assets that will always keep their face value, instead of just owning stocks that could depreciate or lose you money.

3. Keep cash safe at home. Cash is King. Believe it, but remember not to keep it in a thief's favorite spot; like in the bread box or the mattress. These will never have the protection that a quality home safe can provide.

4. Savings Bonds, an old favorite. Savings Bonds are an easy way for your money to stay safe in the future. However, if lost or stolen they could be difficult to replace unless the serial number was kept in a safe place.

5. Gold and silver still shine. If you own gold or silver, great, hold on to it. But if you don't, one of your best bets is to try to get as many U.S. Gov't issued gold and silver coins as you can.

6. Hold on to real estate. With interest rates at historic all-time lows the market is sure to recover and property values will once again bounce back. So those who hold on to their homes for the long term will likely reap the benefits of these investments.

7. Buy a good safe. Home safes become an absolute necessity during economic turmoil. But, because of the huge spike in recent sales, safes may be hard to come by.

With all this you'll be much safer, just in case your bank is the next to fail. ■



HELP IS ON THE WAY: This never-before-seen photo captures the rapid shipment of free Presidential Armored Safes now being shipped to U.S. citizens across the country. The World Reserve is handing out the Armored Safes free to the general public who rush to call the National Delivery Hotline at 1-866-948-2597 and beat the 7-day order deadline to buy up the newly released World Reserve Collection consisting of 4,100 U.S. Gov't issued coins.

Terms & Conditions: The monthly shipment of coins will begin when it has been confirmed that you properly received delivery of your free Armored Safe and first shipment of coins. You'll only need to cover the freight for the safe and $98 for the first shipment of coins then the same amount for the remaining eighteen monthly shipments to complete the entire collection of 4,100 U.S. Gov't coins. THE NO-WORRY GUARANTEE ENSURES THAT REFUNDS MADE DURING THE EIGHTEEN MONTHS WILL BE GRANTED FOR ALL ITEMS PROPERLY RETURNED, LESS SHIPPING. THAT MEANS, CANCELLATION WILL ALSO REQUIRE THE RETURN OF THE FREE ARMORED SAFE. FAILURE TO DO SO WILL REQUIRE REMITTANCE FOR THE SAFE OF FOUR HUNDRED AND THIRTY SIX DOLLARS. THE WORLD RESERVE MONETARY EXCHANGE, INC. IS NOT AFFILIATED WITH THE U.S. GOVERNMENT OR ANY GOVERNMENT AGENCY. THE INCREASE IN COLLECTIBLE VALUE OF CERTAIN PRIOR ISSUES OF U.S. COINS DOES NOT GUARANTEE THAT CURRENT ISSUES WILL ALSO INCREASE IN VALUE. OH AND FL RESIDENTS REQUIRE THE REMITTANCE OF APPLICABLE SALES TAX. SORRY NO SHIPMENTS TO VT AND MA RESIDENTS.

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Free safes being doled out to public

Armored Safe giveaway ends public worry for those who rush to buy up hoards of brilliant never-circulated U.S. Gov't issued coins that never lose their cash value

BY SHAWN OYLER

Imagine finally getting something that will never lose its value.

Sounds too good to be true? Well, it's true and word is quickly spreading about the free handout of Armored Safes that are being stocked with the 4,100 brilliant, never-circulated U.S. Gov't issued coins that by law will never be minted again.

These free Armored Safes are being turned over to the general public who make it in time to beat the order deadline for their share of the hoard of brilliant, never-circulated U.S. Gov't coins before the 7-day shutoff.



LIKE WINNING THE LOTTERY: Everyone who gets this huge hoard will receive 4,100 brilliant, never-circulated U.S. Gov't issued coins including 100 Presidential Golden Dollar Coins and 16 heavy vault bricks containing 160 sealed vault rolls of never-circulated U.S. Buffalo Nickels for a total of 4,100 coins.



NO MORE WORRIES: Carol Ford of Perry, OH said she hit the jackpot when her free Armored Safe was delivered. "I already have some old coins, but I wanted these U.S. coins as a nice nest egg. Now I can keep all my important papers and my Dad's gun in my new safe," she said.

"The frantic demand for U.S. Gov't coins has caused the U.S. Mint® to officially halt minting of many of its most valuable coins," said lead consultant for the World Reserve Thomas C. Harris, Retired Deputy Director of the U.S. Treasury Bureau of Engraving and Printing.

"Today, the World Reserve has stepped in to release this hoard consisting of 4,100 U.S. Gov't issued coins in a free Armored Safe to the general public. Having valuable U.S. Gov't coins serves as an economic life raft. This valuable Collection will never, never, never lose its face value. You will always have something worth a lot of money," said Harris.

Here's the best part, among the 4,100 never-circulated U.S. Gov't coins that everyone gets there are 100 of the highly sought after Presidential Golden Dollar coins.

Here's why that is so important. Just think if you would have saved the same number of uncirculated Eisenhower Dollar coins from 1974. Remarkably, they would now be worth 500% more in collector value.

This gives you a hint that these are not the same grade as the coins found in loose change, or from the local bank. In fact, these coins will remain in brilliant, never-circulated condition if left sealed and untouched.

U.S. Gov't Savings Bonds used to be a favorite way to keep money safe and popular to give as gifts. But no one can take a Savings Bond and go buy something with it.

That's why this hoard of valuable coins gives everyone the comfort of having full control of their money. No matter what, they will never lose their U.S. cash value.

If times ever get really tough any coin in the hoard could be used to buy anything. But unless it is a good reason, only a fool would do that because this personal hoard of money is already worth so much more than face value.

"So many people are buying up these coins. Even for those people who give away some of their collection as gifts, they are keeping the Armored Safe for themselves," said Robert Anthony, Director of the private World Reserve Monetary Exchange.

"This Safe is one of the absolute best places to keep valuables and important papers. People will now have a safe place to store their wills, guns, jewelry, antiques, keys, coins and even cash," Anthony said.

"The only problem the Safe creates is when it's time to read your Will. You need to make sure everyone knows who you want to leave it to," he said.

"When Americans get their hands on this Safe and their very own personal hoard of U.S. Gov't Coins, they'll really do a double take. Everyone will feel like they just won the lottery," he said. ■

How to get the free Armored Safes

All those who beat the 7-day order deadline and take delivery of the entire hoard of 4,100 U.S. Gov't issued coins from the World Reserve will actually be awarded the Presidential Armored Safes absolutely free.

Eligibility: Certain restrictions apply: 1. Open to the public only, sorry no dealers. 2. Those who miss the 7-day deadline will be turned away from this free offer and required to wait for future announcements, in this or other publications. 3. The entire World Reserve Collection must be obtained.

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THIS IS MY JOB

WILDFIRE PARAMEDIC



- MICHAEL "KALE" CASEY
- LOCATION: PUEBLO, COLO.
- AGE: 37
- YEARS ON JOB: 4

1. Helmet Casey wears this heat-resistant thermoplastic helmet for impact and penetration resistance. He outfits the helmet with a headlamp, which has both LED and halogen lights.

2. Chest Harness with Radio and GPS Casey lives in this harness, because it holds his most vital tool, the radio. When a helicopter is needed to evacuate a patient, Casey radios GPS coordinates of a landing zone to the command center.

3. Pulaski Ax In order to be an EMT-paramedic, Casey must also be trained to fight fires. He uses this ax to chop and dig fire lines in rocky, brush-filled ground.

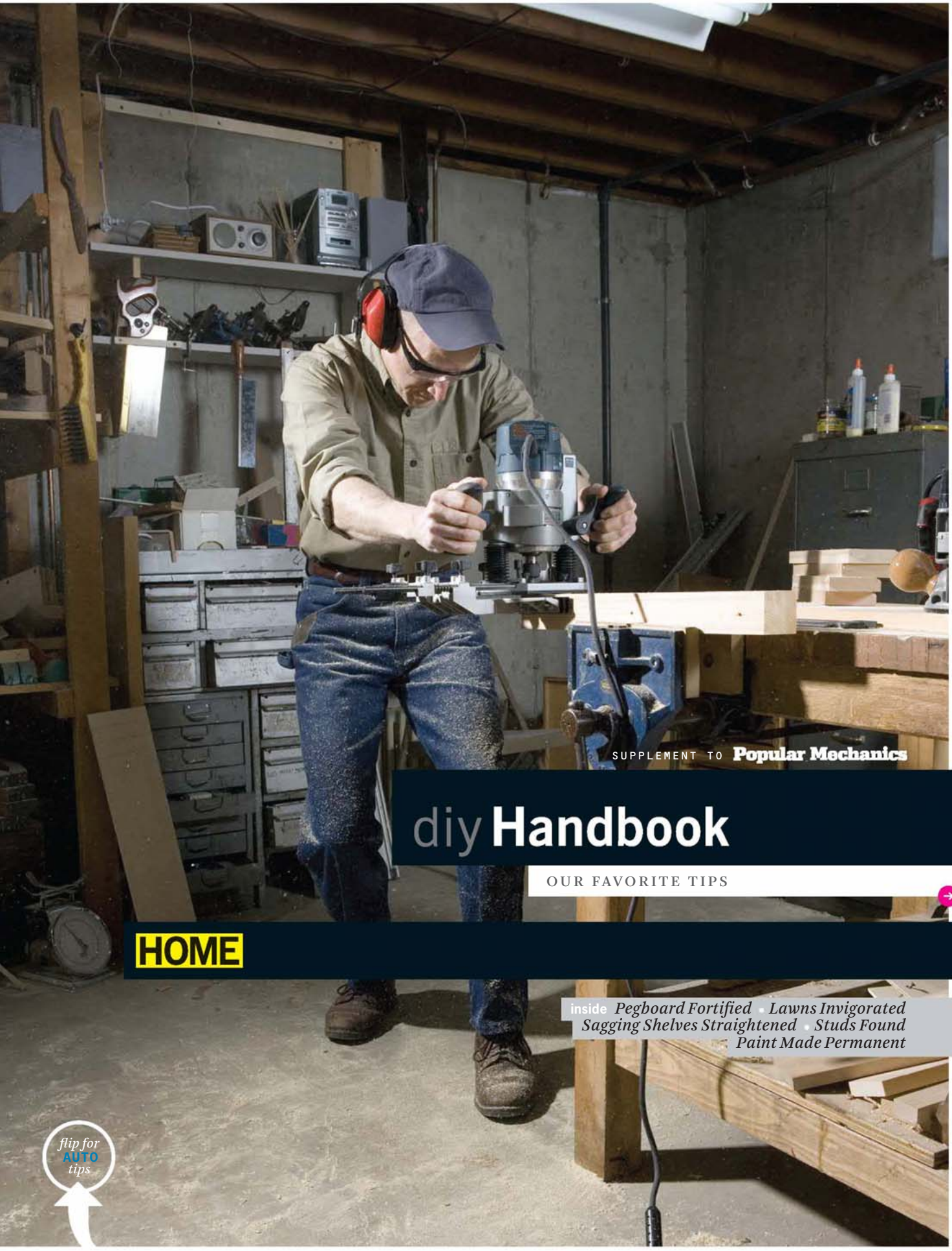
4. Fireproof Clothing Firefighters routinely walk through 1-foot flames; abrasion-resistant Nomex fabric, made by DuPont, won't melt or support combustion in the air.

5. Sked This polyethylene plastic rescue system has a lightweight backboard and stretcher, used for high-angle rescues in the mountains. It rolls into a tubular pack.

6. First-Aid Kit Casey's kit holds an ambulance-worth of gear, including a stethoscope, rescue drugs, a 15-cubic-foot oxygen tank—and intubation equipment that he's never had to use. "I hope I never have a patient so badly injured that he needs an advanced airway," he says.

The 2008 wildfire season was a busy time for EMT-paramedic Michael Casey, who battled flames for weeks on end while caring for the wounded along the spine of California's steep, rugged backcountry. Casey will work anywhere, but drought, dry fuel and strong winds make business especially brisk from the state's northern Klamath Range to the southern Sierras. The firefighters who helicopter into big fires suffer dehydration, burns, breathing problems and occasionally massive injuries when flaming Douglas firs and other behemoths crash down. "In a day you may treat 20 folks or 200," he says. "You've got to love serving people." *— SARAH SHATZ*

PHOTOGRAPH BY **SARAH SHATZ**



SUPPLEMENT TO **Popular Mechanics**

diy Handbook

OUR FAVORITE TIPS

HOME

inside *Pegboard Fortified* • *Lawns Invigorated*
Sagging Shelves Straightened • *Studs Found*
Paint Made Permanent

flip for **AUTO** *tips*

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HOME tips

tip no. 01

OUTDOOR PAINTING

In outdoor painting, 80 percent of the work is preparation. First, wash the surface to remove dirt and kill mildew. Scrape loose paint and feather-sand rough edges. Finally, brush and rinse away sanding dust. Repair damage. Now you're ready.

Begin with a coat of primer. Spot-prime bare patches, but prime the entire surface if it's weather-beaten or needs a lot of scraping. Next, apply the topcoat to the siding. Cut in along the trim using a trim brush—switch to a roller for large, flat areas. Apply two topcoats. Finish the job with gloss or semigloss enamel applied to the trim. Again, apply two coats.



Build Right to Make It Last

Use vertical-grain boards (look for straight lines, not ovals, on the wide face). These expand and contract less than flat-sawn wood.

Shape wood so it sheds moisture. On porch balustrades, cut a peak into the baluster's bottom rail, and notch each spindle to fit it.

Use corrosion-resistant nails and screws such as hot-dipped galvanized or stainless-steel. Otherwise, rust will blister and break through the paint.

Pretreat wood to increase moisture-resistance. Apply a clear, paint-compatible, water-repellent preservative before priming.

PHOTOGRAPH BY CHRIS ECKERT/STUDIO D; ILLUSTRATIONS BY BRADLEY R. HUGHES; COVER PHOTOGRAPH BY ZACH DESART

HOME
tips



tip no.
02
↓
MARKING
IMPLEMENTS

Snapped-Off Hacksaw Blade
Scores a ragged line into concrete, asphalt, rusted metal. *But:* The junkyard dog of marking tools, it's not particularly precise.



No. 2 Pencil
Marks fine lines on softwood and light-colored hardwood for building furniture, cutting trim. *But:* Tip breaks frequently on rough, heavy-duty jobs.



Carpenter's Pencil
Marks reasonably dry construction lumber. It's rugged. *But:* Even when sharp, won't mark fine lines for precise cuts.



Marking Knife
Cuts a very fine line into lumber for furniture construction. *But:* Since the line is cut, it can't be erased—the mark's got to be right the first time.



Indelible Sharpie
Marks any smooth, light-colored material (lumber, glass, PVC, vinyl, aluminum, brass, copper or steel). *But:* Soft tip is easily damaged.



Carbide-Tip Scriber
Makes a very fine line on tile and metal (aluminum, copper, brass, high-carbon steel, cast iron). *But:* Tip cannot be sharpened once dull.



Awl
Scribes soft metals (low-carbon steel, copper, brass, aluminum). It can be sharpened. *But:* Can't readily scribe hard, high-carbon steel and tile.

tip no.
03
↓
STICK IT
TO A
MAGNET

3 WAYS TO HOLD SMALL PARTS

1. BRANDISH A TELESCOPING MAGNETIC WAND TO RETRIEVE PARTS AND SWEEP UP METAL SHAVINGS.
2. KEEP A BUTTON MAGNET IN YOUR POCKET TO HOLD SCREWS, NUTS AND BOLTS TOGETHER. (IT WILL ALSO KEEP THEM FROM ROLLING AWAY IF DROPPED.)
3. USE A MAGNET DISH TO HOLD HARDWARE, ESPECIALLY ON APPLIANCE JOBS. IT CLINGS TO HORIZONTAL OR VERTICAL SURFACES, AND THE SMALL CHARGE IT LENDS SCREWS WILL HELP THEM STICK TO A SCREWDRIVER TIP.



PHOTOGRAPHS BY J MUCKLE/STUDIO D

tip no.

04

SET UP SHOP

Remodeling will go more smoothly if you follow these rules.

1. Check to see if you need a building permit—for substantial jobs, you do.

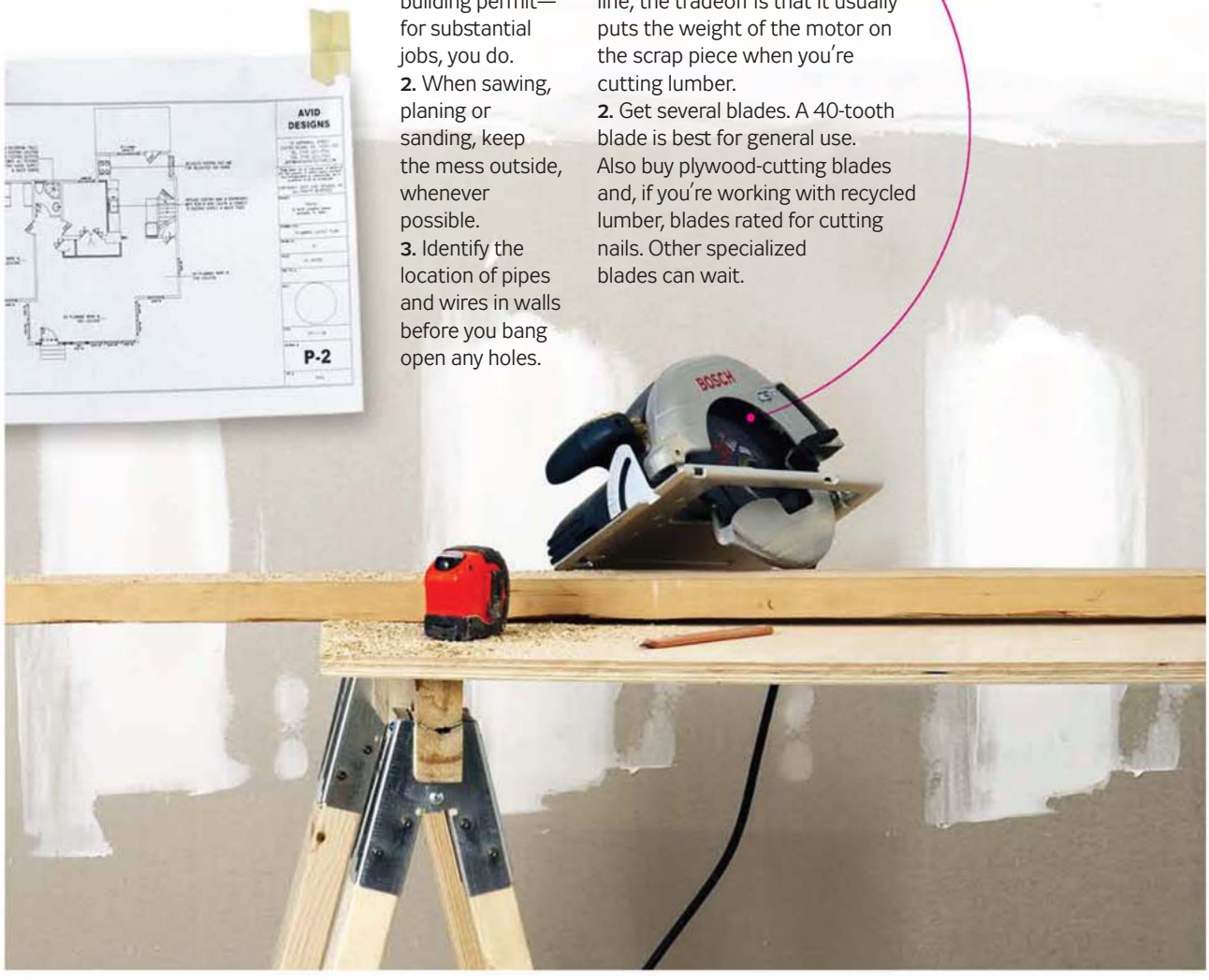
2. When sawing, planing or sanding, keep the mess outside, whenever possible.

3. Identify the location of pipes and wires in walls before you bang open any holes.

The circular saw is the backbone of every remodeling job. Here's a shopping guide.

1. Saws come in left-blade versions (shown) and the more typical right-blade versions. A lefty gives you a better view of the cut line; the tradeoff is that it usually puts the weight of the motor on the scrap piece when you're cutting lumber.

2. Get several blades. A 40-tooth blade is best for general use. Also buy plywood-cutting blades and, if you're working with recycled lumber, blades rated for cutting nails. Other specialized blades can wait.



tip no.

05

DOOR JAMS

WHEN LATCHED INTERIOR DOORS RATTLE, IT'S USUALLY BECAUSE OF A POOR FIT BETWEEN THE LOCKSET, STRIKE PLATE AND DOORSTOP MOLDING. ***SILENCE THE NOISE BY BENDING OUT THE STRIKE PLATE'S TAB, WHICH RESTS AGAINST THE LATCH WHEN IT'S CLOSED.*** EITHER PRY OUT THE TAB IN THE DOORJAMB USING A SCREWDRIVER, OR UNSCREW THE STRIKE PLATE, BEND THE TAB WITH PLIERS AND REINSTALL THE PLATE.

PHOTOGRAPH BY CHRIS ECKERT/STUDIO D

HOME tips



make your own!

CORDLESS DRILL
+
RECYCLED PLASTIC JUG
+
1/4-INCH STEEL ROD
+
NUT AND WASHER
+
SPRAY-PAINT-CAN CAP
+
WASHER AND NUT

tip no. 06

↓ SPREAD SALT WITH SPEED

To ease de-icing chores, cut out the side of an old jug to create a supersize salt shaker. Make an impeller shaft by cutting "fins" into a plastic spray-paint-can cap; bolt the impeller to a steel shaft; slip the shaft through the bottle neck and chuck it into the drill. Wear eye protection, pull the trigger and let the salt fly.

tip no. 07

↓ TOILET-FLUSH FIX

A toilet with a weak flush is a nuisance and a water waster. First, lift the tank lid and check that the water meets the tank fill line. Next, test-flush the fixture. The handle, its chain and the flapper should be adjusted so that one downward flip of the handle lifts the flapper briskly. The flapper should stay suspended long enough for water to fill the bowl. If not, adjust the flapper's chain accordingly.



PHOTOGRAPHS BY J MUCKLE/STUDIO D (SALT SPREADER), GETTY IMAGES (TOILET)



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HOME tips

tip no. 08

PEGBOARD POTENTIAL

Make the most of pegboard.

1. When mounting it to drywall, use 1 x 2 stock or strips of 3/4-inch plywood. The space behind the board will leave room to hang hooks and hardware.
2. Distribute the load. Heavier objects need more substantial hanging hardware. Large hammers, pry bars, shovels and rakes are best mounted through the pegboard to the wall framing or the wooden furring strips behind the board.
3. Attach magnetic bars to hold small tools and frequently used metal parts.

tip no. 09

HOMEMADE HARDWARE HANGERS

In our humble opinion, pegboard is the best thing to happen to the American shop since 120-volt power. Okay, maybe compressed air is better than pegboard, but it's a tough call. *Don't put up with loose hooks and junky hangers. Make your own hardware* and fasten it with hefty sheet-metal screws.



Hammers
Asymmetrical heads make hammers, hatchets and pry bars hard to hang evenly. The solution is to bend aluminum flat stock to make your own hanging hardware. Attach the brackets with hexhead sheet-metal screws.

Drivers
Tools with a shaft and a handle, like screwdrivers and nut drivers, can hang with the handle up or down. Make the hanging hardware from steel or aluminum tubing, or L-shaped angle stock.

Gripping and Cutting Tools
Pliers and diagonal cutters can straddle or slide behind a mount shaped from small-diameter bar stock. Bend the ends into hooks, then shape the body into a rack.

PHOTOGRAPH BY CHRIS ECKERT/STUDIO D



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HOME
tips

tip no. 10

RAISE SAGGING SHELVES

need a lift?

Every bookcase has a shelf sagging beneath too many books. An overload looks bad and can lead to a literary avalanche. *Support it with a vertical divider cut from ¾-inch plywood, tall enough to prop up the shelf to its original, level height.* Conceal the exposed plywood edge with veneer edge banding (or, if you're feeling crafty, a tailored book jacket). To support the upper shelves and prevent further sagging, the lowest divider must rest on the bottom of the bookcase.



PHOTOGRAPH BY DAN SAELINGER

HOME tips



tip no. 11

JUNCTION FUNCTIONS

TO PAIR UP DATA CABLE AND ELECTRICAL LINE VOLTAGES, USE A BOX LIKE THE ONE SHOWN HERE, WHICH IS UL-RATED FOR THIS SPECIFIC PURPOSE. THE BOX MUST HAVE A DIVIDER TO SEPARATE THE LOW-VOLTAGE AND LINE-VOLTAGE SIDES. COBBLE TOGETHER A STANDARD ELECTRICAL BOX AND OTHER EQUIPMENT AND YOU'LL CREATE AN ELECTRICAL CODE VIOLATION.

tip no. 12

CLASSIC 1940 A SOFTER SAWHORSE

PM advises reusing inner tubes from old tires as padding on sawhorses to prevent damage to delicate woodwork.

modern angle: Today, those inner tubes aren't quite as ubiquitous. Instead, wrap sawbucks in carpet scraps or old cardboard to protect workpieces from scratches.



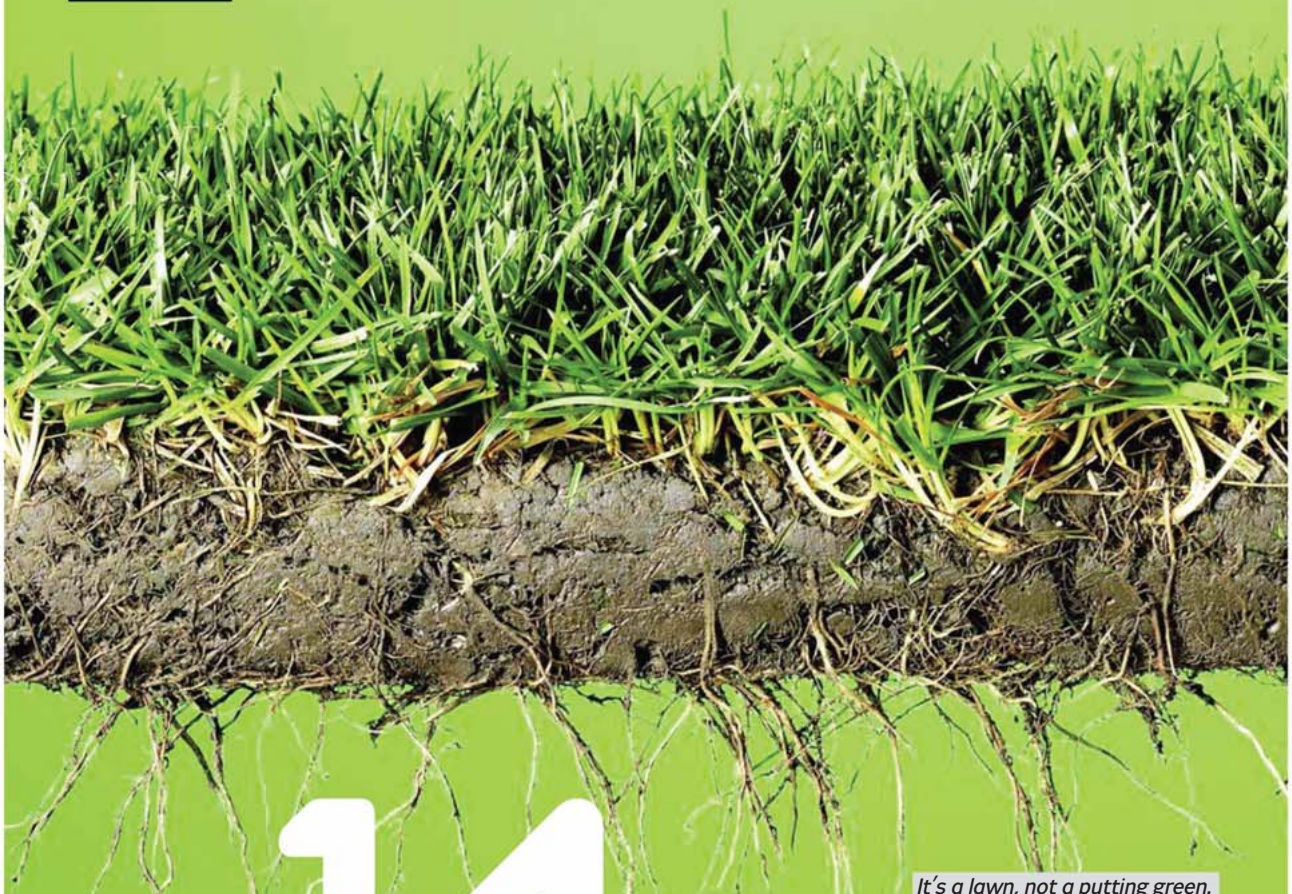
tip no. 13

BRICK BUMP

Use the butt end of a brick trowel to gently bump a brick into place. It's not unusual to place a brick in its mortar bed and find that you can't shove it completely into position, which should be about 1/16 to 1/8 inch set back from the mason's line, and level across its width and length. *If you're an amateur bricklayer, you'll find that brick trowels with a bumper on the end of the handle are particularly useful.* It may take a lot of bumping to nudge bricks into position.

PHOTOGRAPH BY YOKO INOUE

HOME
tips



tip no.
14

MAKE GRASS LAST

WANT A THICK, GREEN LAWN? HERE'S THE RIGHT WAY TO GET IT.

A LAWN NEEDS ABOUT 1 INCH OF WATER A WEEK. USE MORE ONLY IF THE WEATHER IS VERY HOT OR WINDY. IF THE LAWN GETS A LITTLE BROWN AND BRITTLE IN THE SUMMER, RELAX—IT'S GONE DORMANT. IF IT'S HEALTHY, IT'LL BOUNCE BACK.

SWEEP UP FERTILIZER THAT SPILLS ON DRIVEWAYS AND WALKS TO KEEP IT FROM WASHING INTO WATERWAYS.

It's a lawn, not a putting green.
To avoid cropping grass too short, stressing the plants unnecessarily, set your mower to the highest or second-highest setting.

Healthy soil, healthy grass.
Cool-weather grass is hardy stuff. It grows well in soil with a pH anywhere between 6 and 7. Aerate soil annually and avoid compaction by foot traffic or machinery.

A little dead grass is normal.
But when that layer builds above a half-inch, it's thatch. Remove it with a power rake.

Dark green is good.
It shows that the lawn is healthy, watered and fertilized with adequate nitrogen and trace amounts of iron.

PHOTOGRAPH BY LEVI BROWN

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HOME
tips



15

tip no.

When we wrote about finding studs 50 years ago, we called the process "dowsing"—and it really was nearly as hard as looking for underground water with a fork-shaped stick. Whether you used magnets, drove nails above the baseboard or simply tapped and listened, looking for studs was a time-consuming job.

↓
CLASSIC
1960
WHERE THE
STUDS ARE

modern angle: Stud finders today are a bit more sophisticated—some will even detect an electrical line and determine whether it's live. But the methods PM published in 1960 still work—and you never need fresh batteries.

PHOTOGRAPH BY JEFF WESTBROOK/STUDIO D

HOME tips

tip no. 16

↓

SPRAY-PAINTING

Paint parts before assembly—less work, smooth coats.

DON'T POINT AND SHOOT WHEN SPRAYING PAINT. *SWEEP THE CAN HORIZONTALLY AND VERTICALLY OVER THE OBJECT.* POSITION DIFFICULT-TO-PAINT PARTS ON A BLOCK; SPRAY A COAT, THEN TURN THE BLOCK WITHOUT TOUCHING THE PART.



PHOTOGRAPH BY ANJA HITZENBERGER

HOME tips

tip no. 17

LAUNDRY AID



Fasten a sheet of 3/4-inch plywood to the floor below your washer and dryer. Modern washing machines spinning at high rpm can vibrate badly. The lumber stiffens the floor, dampens vibrations and muffles the machines' noise.

tip no. 18

BORE CLEANER HOLES

You want to drill a 1-inch hole through a piece of lumber, and you don't want to blow out the opposite side when the spade bit comes through. *Clamp a piece of scrap wood to the lumber so that the bit will exit the scrap.* Bore as you normally would. If the bit tears anything as it exits, it'll tear the scrap, not the lumber, which will remain pristine. When you get a moment, file-sharpen the cutting spurs and lip of dull spade bits to reduce their tendency to tear the rim of the exit hole.

PHOTOGRAPH BY FILIP KWIATKOWSKI

HOME tips

tip no.

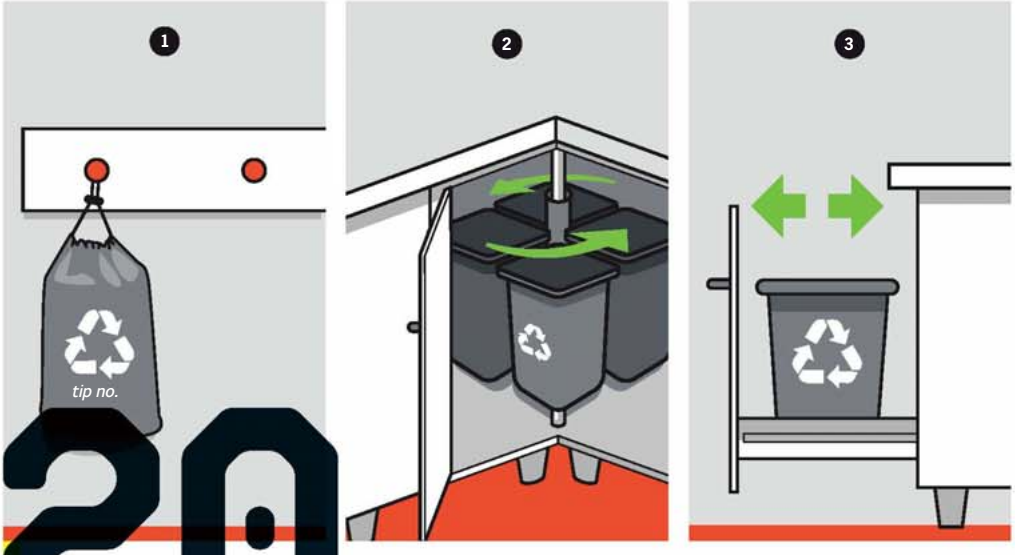
19

↓
CLASSIC
1966
MOUNT ON
MASONRY

To hang a light picture without damage to brick, wedge a wood block between bricks in the mortar line. Drive a nail into the block, mount the frame, and keep a dear friend close to the hearth.



modern angle:
Today, masonry screws anchor in brick. But a wedge is less obtrusive, and works if you're short a hammer drill.



tip no.

20

↓
SORT OUT
RECYCLING
SYSTEMS

Don't let old magazines pile up until recycling day. Organize with smart storage.

1. Bag It.
Suspend a drawstring bag from a coat hook to store cans. Install hooks on a backboard or mount them to wall studs. Toss dirty bags into the laundry.

2. Spin It.
Areas under cabinet corners are often under-used. Get a corner recycling center, which works like a carousel and sorts out items by type.

3. Slide It.
To camouflage recyclable storage within kitchen cabinets, install a waste and recycling container pullout. Double up the containers for large-volume storage.

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ILLUSTRATIONS BY ICONWERK

America's Top Engine Builders Choose Royal Purple

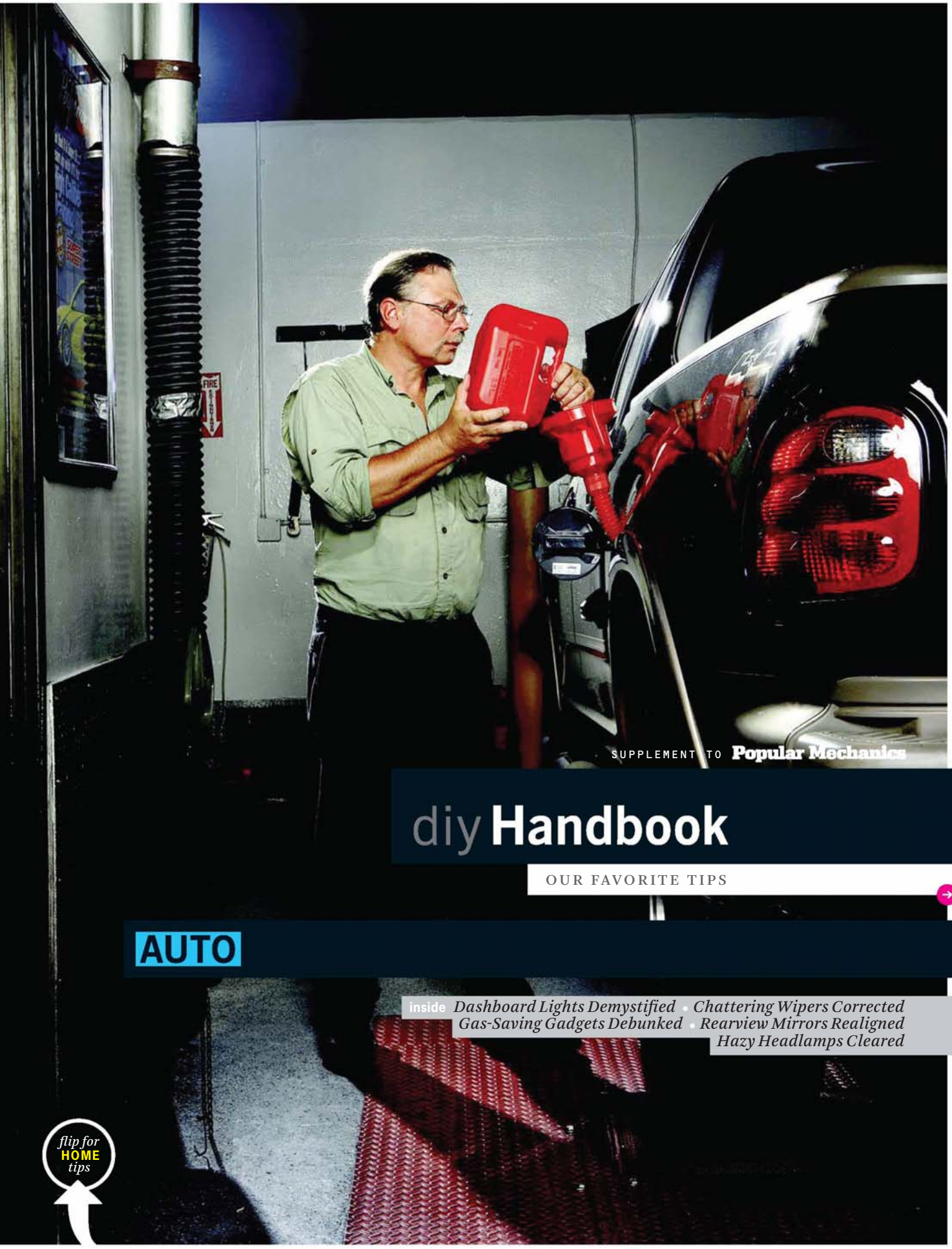
Each year America's top performance engine builders compete for the coveted Engine Masters title and more than $100,000 in prize money. Royal Purple has been used by more winners and finalists than any other brand.

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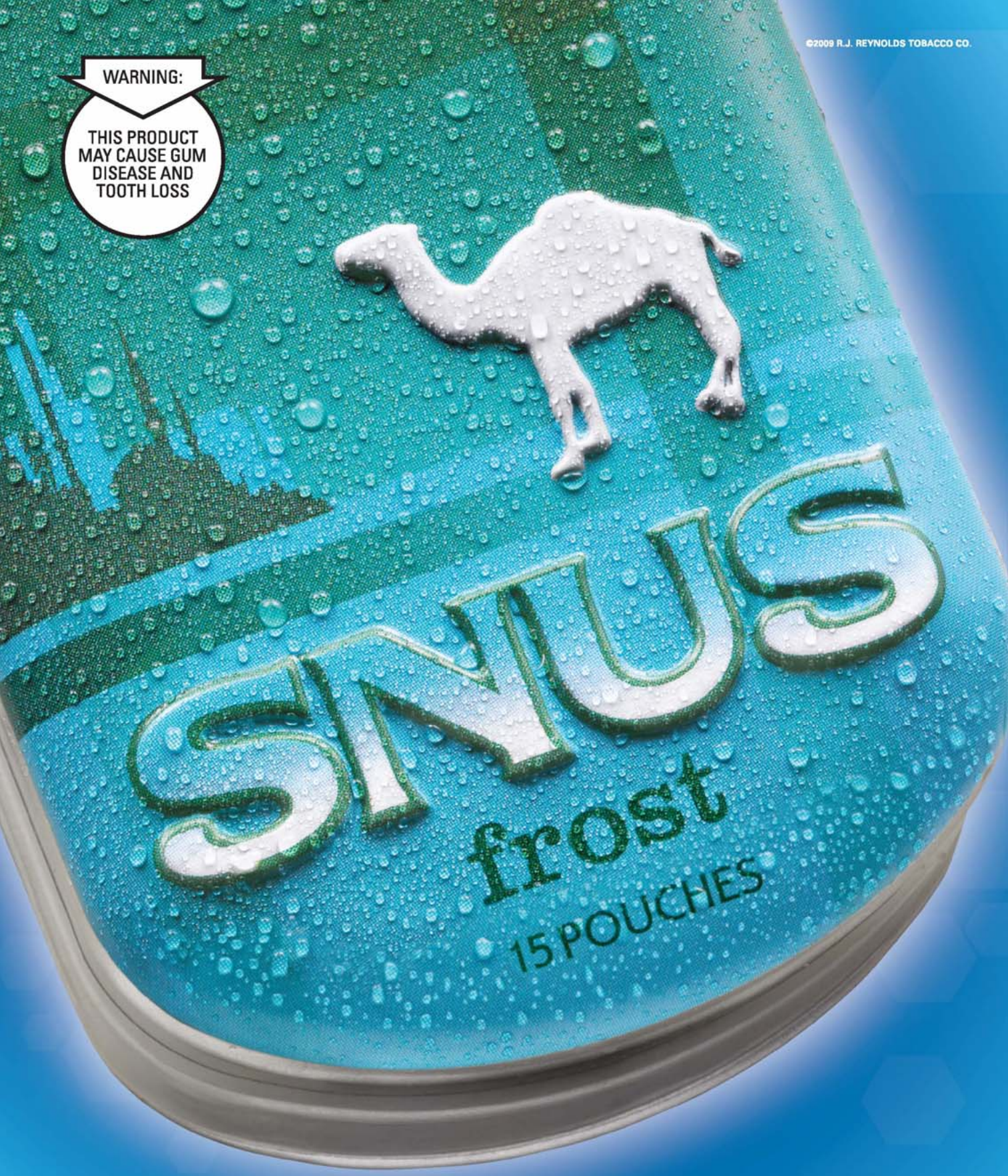
diy Handbook

OUR FAVORITE TIPS

AUTO

inside *Dashboard Lights Demystified* • *Chattering Wipers Corrected*
Gas-Saving Gadgets Debunked • *Rearview Mirrors Realigned*
Hazy Headlamps Cleared

flip for **HOME** *tips*



diy-friendly.

AUTO tips

01

tip no.

ABSOLUTELY SHOCKING



TIRED OF REACHING FOR THE DOOR HANDLE AND JUMPING LIKE YOU'VE BEEN TASED, BRO? ***A HEALTHY SPRAY OF FABRIC SOFTENER OR A RUBDOWN WITH A DRYER SHEET WILL KILL THE STATIC*** PRODUCED BY YOUR CLOTHES RUBBING ACROSS THE CAR SEATS.

PHOTOGRAPH BY JAMES WESTMAN; COVER PHOTOGRAPH BY BRENT HUMPHREYS

AUTO tips

tip no.

02

↓

VISUALIZE

People often don't adjust their rearview mirrors correctly. The interior mirror should be set to see straight back along the road, as most people have them. But many drivers set the mirrors mounted on the doors to duplicate this view. The proper use of these mirrors is to let you visualize the blind spots flanking your car, not to be able to see straight back. *HERE'S HOW TO PROPERLY ADJUST THE MIRRORS:* Adjust the driver's seat to the correct position. Lean your head and torso over to the left until your head contacts the window glass. I know, that seems too far. But trust me. Now, adjust the left-side mirror outward until you can barely see your own fender in it. Next, lean over to the right a similar distance, and adjust the right-side mirror so you can, again, just see your own rear fender. Sit up straight. Your mirrors are now set to allow you to see cars in your blind spot. You won't need to swivel your neck around to be aware of other vehicles hiding while they drive 60 mph right beside you. The interior mirror will still let you see the traffic directly behind.



tip no.

03

↓

NIGHT
BLINDNESS

Interior dashboard lights are necessary to let you see the speedometer and other instruments. But don't leave the brightness of the panel lights up so high that it affects your ability to see outside the car. It isn't so critical in town, but out in the boondocks, it's dark outside, baby. *Try this: While driving along a really dark stretch of road, turn the panel lights completely off for a couple of miles, to allow your eyes to adjust.* Slowly inch them back up until you can read the speedo. That will be the perfect level. And make sure your nav system is on the nighttime setting, while you're at it.

ILLUSTRATION BY GOLDEN SECTION GRAPHICS

AUTO tips

tip no.

04

SAFETY-PINNED

A lot of mission-critical automotive fasteners use cotter pins to prevent inadvertent, spontaneous disassembly, which can be inconvenient, if not outright dangerous. Those cheapo cotter pins are supposed to be replaced every time they're used. Sure. But sometimes, you just have to get home from an off-roading excursion, or maybe the hardware store is closed by the time you get to final assembly at 3 am before the big race. *A safety pin will serve temporarily.* And it will look so dorky you'll be shamed into replacing it with the proper cotter pin as soon as you can.

tip no.

05

BULB JOB

Avoid common errors when changing brake and taillight bulbs. One frequent mistake is to replace an 1157 bulb (two filaments) with a similar single-filament 1156. Note that the retaining pins are located in different parts of the bulb. Don't try to force the wrong bulb into place.



CHECK PIN PLACEMENT

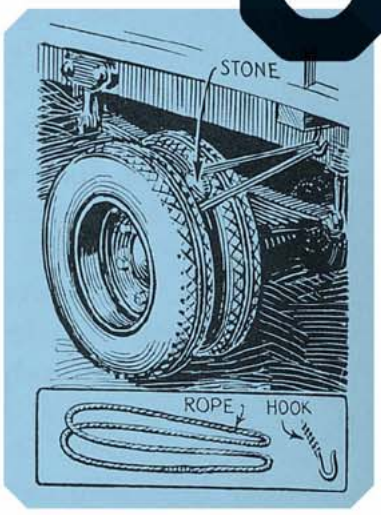


PHOTOGRAPHS BY CHAD HUNT

AUTO tips

tip no. 06

CLASSIC 1940 STICKING STONES



The more things change, the more they stay the same. If you drive a dually pickup or a box van with dual rear wheels, eventually you'll wedge an egg-size rock between the sidewalls. Talk about an out-of-balance shimmy when you hit the freeway! Lasso that stone with a piece of rope wrapped around the spring perch or bumper. Once you wrap up the rock, idle slowly along for a few feet until it's dragged out. And don't stand in the line of fire in case it slingshots. It helps to let some air out of the tires while trying this.





tip no. 07

BRIGHT IDEA

Polycarbonate headlamp lenses are prone to hazing up, and the discoloration and milkiness can cause a huge reduction in nighttime visibility. Head down to the auto-parts store or auto department at your local mass merchandiser and pick up a headlight-polishing kit. We've tried some from Turtle Wax, Loctite and others; it only takes a half-hour or so to use one. Mask off the lens with tape to protect the paint and trim. Then use the sandpaper in the kit, in successively finer grades, to sand off the damaged layer of plastic. Follow up with polishing compound on a rag, and the lens will look like new. Be sure to coat the fresh surface with wax to protect it from the elements.

PHOTOGRAPHS BY JAMES WESTMAN

Mr. Punch on politics...



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AUTO
tips



tip no.

08

THINK
THIN

Lifting cars doesn't have to be dangerous. First, block the wheels. The preferred place to lift is from the jack points shown in the owner's manual. If you need to lift from somewhere else, use a suspension pickup point, the bottom of a ball joint, a transmission or differential case or a crossmember. Bad places to lift from: radiators, oil pans, sheet-metal floors and spare-tire wells. Be sure the jack's wheels can roll easily as you lift or the car will slide off the jack pad as it arcs up.

PHOTOGRAPH BY CHAD HUNT

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Friction wears out cylinder walls inside every car's engine. This causes ***power-robbing*** compression leaks between piston rings and cylinder walls.

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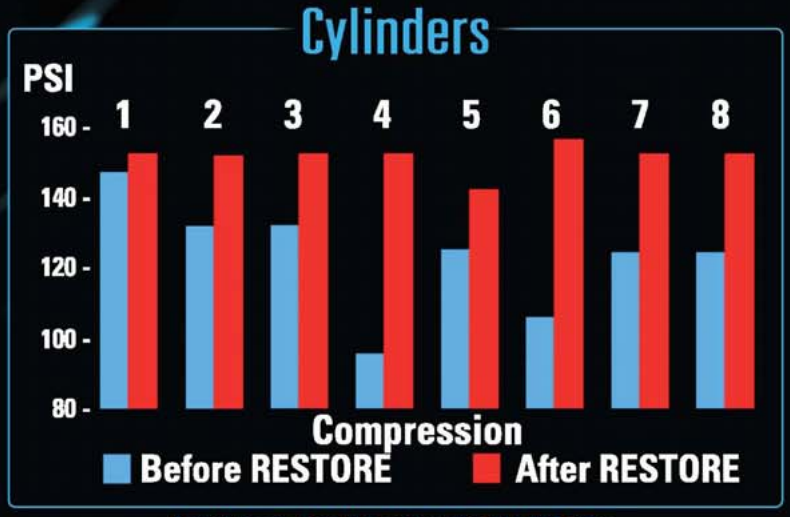
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AUTO tips

tip no. 09

CRUSH HERE



We always advocate using a socket or flare-nut wrench on brake fittings. But sometimes you find one molested by someone who doesn't read PM. It's already round, so who cares if you use Vise-Grips? *To keep from crushing the bleeder or fitting, insert a drill bit exactly the size of the hole into the center.* It'll shore up the thin metal and let you use plenty of torque.



tip no. 10

TRIAL AND ERROR

DON'T GUESS WHY YOUR CHECK ENGINE LIGHT IS ON. YOU CAN PICK UP A SIMPLE CODE READER FOR AROUND $50. CHEAPER YET, MOST MASS-MARKET AUTO-PARTS STORES HAVE A GENUINE SCAN TOOL YOU CAN BORROW FOR AN HOUR OR TWO FOR FREE. AND YOU'LL ALREADY BE AT THE PARTS STORE WHEN YOU FIGURE OUT WHAT'S WRONG!

PHOTOGRAPHS BY CHAD HUNT (TOP), JAMES WESTMAN (BOTTOM)





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AUTO
tips


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GET FREE INFORMATION

CHRYSLER
Have tried the Vacu-matic and it sure is fine. Better pick-up with a 30% gas saving.—John C. Martin, Pa.

PLYMOUTH
I am amazed at Vacu-matic performance. It's giving me 5 more miles per gallon.—Walter Zielinski, Ill.

FRANKLIN
With Vacu-matic I have increased my mileage from 10.1 to 14.2 miles per gallon. I figure I save over $75.00 a year in gasoline.—R. K. Radtke, Wis.

SAVES $180 A YEAR
On my Plymouth 6 I obtained an average of 22 miles per gal. lon, an increase of 7 miles. This means a saving of $15 a month or $180 a year.—F. S. Peck, Calif.

ALL WELL PLEASED
Enclosed find order for 12 more. Everyone I have sold is giving from 4 to 6 more miles per gallon. I have 3 more orders for V8 Ford. Every body is well pleased.—J. O. Catll, Texas.

V-8 FORD
I installed both Vacu-matics and they work excellent. On my own V8 Ford I notice wonderful performance in pickup, get-away and gas saving.—Burt Burnett, Mich.

BUICK
Everything you claim about Vacu-matic is true. I now get 20 miles to the gallon. Before I was only averaging 15½ miles.—C. Constantine, Fla.

CHEVROLET
Please send me a Vacu-matic for a Model A. The mileage on my 1933 Chevrolet jumped from 18 to 22 miles per gal. with Vacu-matic.—Paul P. Haas, Mass.

MODEL A FORD
Have been using the Vacu-matic for a month. I used to get 20 to 22 miles per gal. Now I get 30 to 33 miles. It is amazing the difference it makes.—James W. Barr, Canada.

NASH
On my Advanced 6 Nash gained 17½% in mileage. The car will idle down to 3 miles an hour and then take off without a complaint.—J. Showalter, Mo.

DODGE
Just completed 2310 miles on 92 gallons in my 1933 Dodge 6. This figures 25 miles while before I averaged only 20 miles per gal. on trips.—Al Fruzyna, Calif.

OLDSMOBILE
I am well pleased with Vacumatic on our Oldsmobile. A test proved it to give 18 miles per gal. Before we considered 13 good.—Arthur Williams, N. Y.

Above are just a few of the many unsolicited letters received from Vacu-matic users.

VACU-MATIC
the Carburetor Control that "BREATHES"

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New—Automatic—Nothing Like It!

The self-starter—four wheel brakes—knee action—streamlining . . . and now VACU-MATIC! The greatest motor improvement of recent years! With it, engineers have achieved a practical means of balancing air and gasoline automatically for all speeds. Vacu-matic is entirely different! It is AUTOMATIC and allows the motor to "breathe" at the correct time, opening and closing automatically as required. No idling troubles— adjustments necessary. Just put it on and forget it. Fuel wastes, saves dollars in gas costs, reduces engine new pep, greater power and longe

Fits

VACU-MATIC is constructed assembled and welded into adjusted and sealed at the to regulate. Any motorist MATIC in ten minutes. reminder is the surge of speed it gives to the m it affords your pocketb

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OFFER COUPON

tip no.

↓
CLASSIC
1935
GASLIGHT
GADGETS

There's one born every minute. Even back when gasoline was 10 cents a gallon, motorists were ready to spend money to reduce their fuel bills. In decades of testing, we've never found a gasoline-saving device that magically improved a car's ability to squeeze more miles out of a gallon of petroleum. Any that claims to improve the combustion inside your engine and make dramatically large reductions in your fuel consumption probably can't.

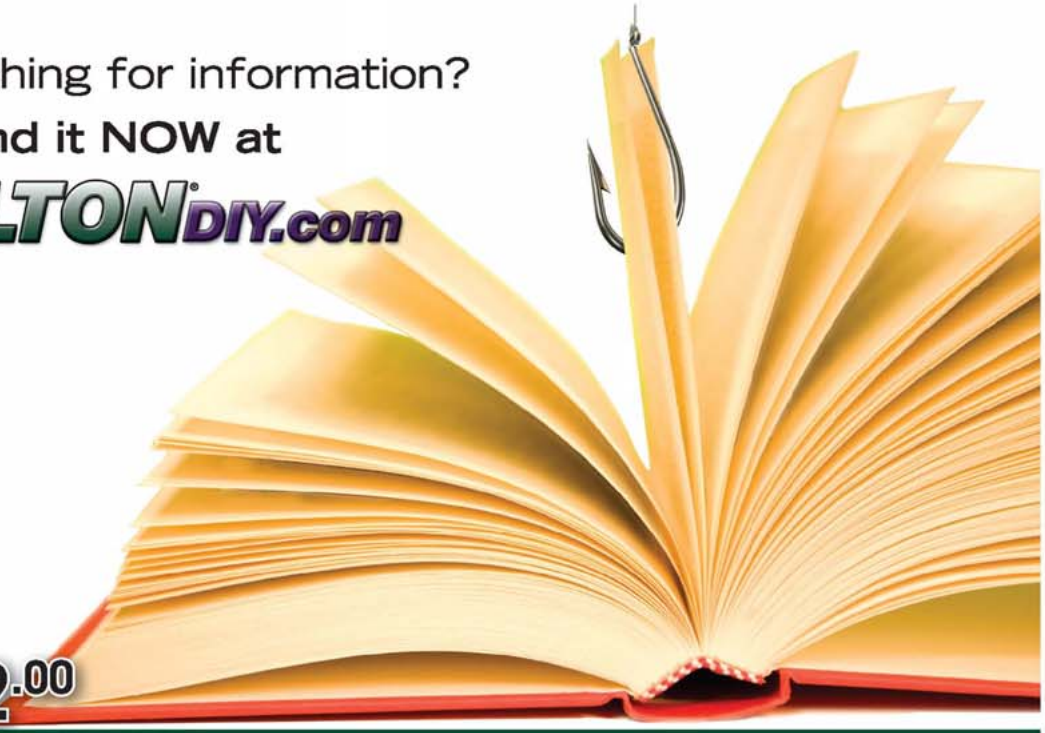
You can, however, buy instruments that will help you hone your driving skills for better economy. There are low-rolling-resistance tires coming on the market that deliver better mileage without reducing grip. Fuel-injection-cleaner additives can sometimes restore the original mileage and power to an engine whose performance has dropped off. But anything that sounds too good to be true probably is.

PHOTOGRAPH BY JEFF WESTBROOK/STUDIO D

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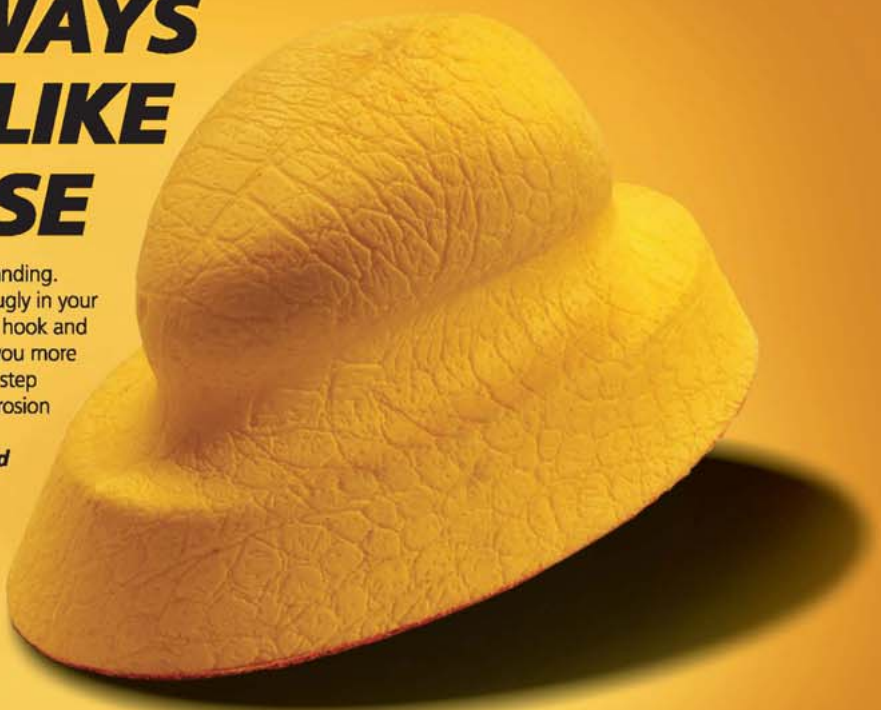
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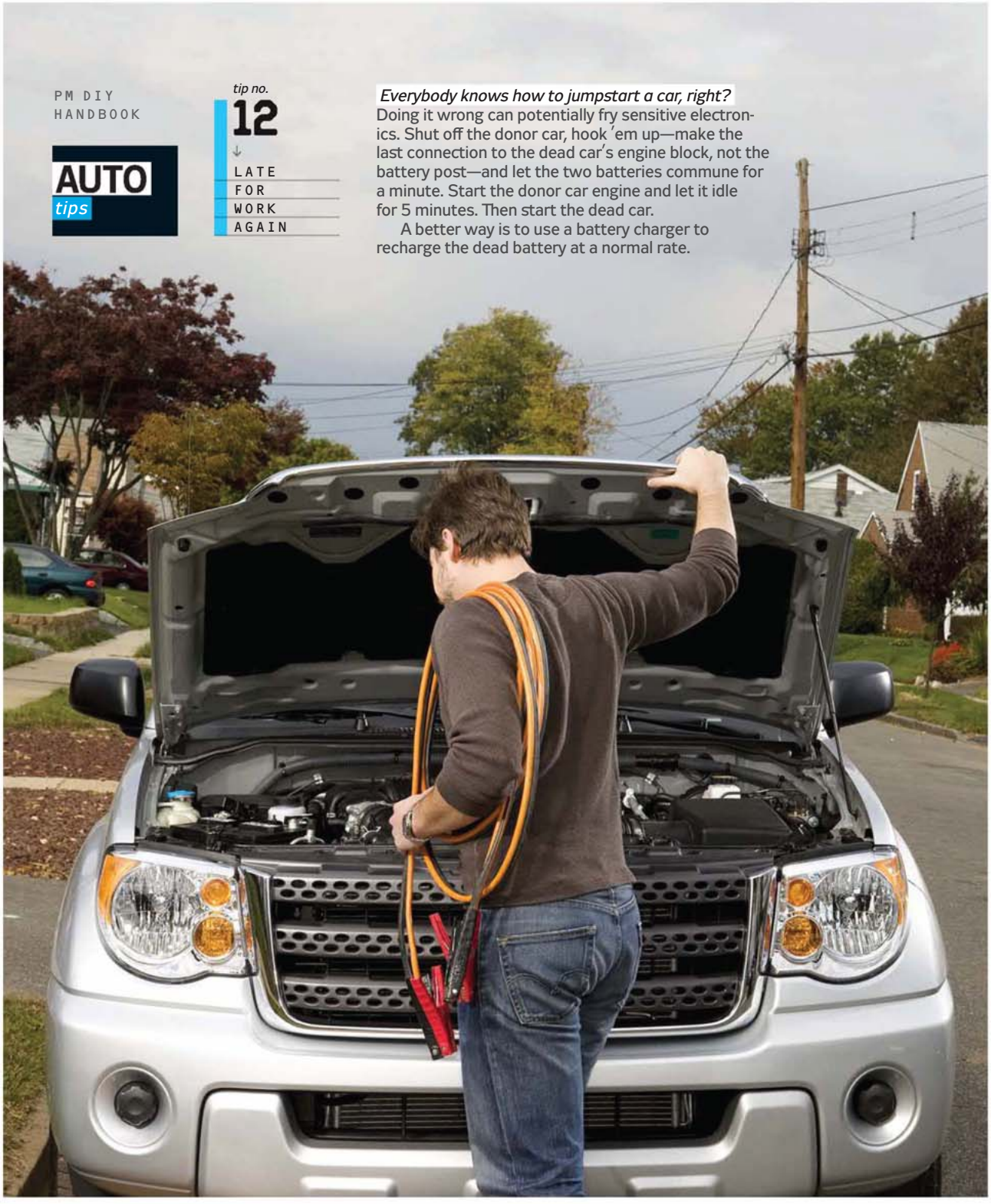
AUTO tips

tip no. 12

LATE FOR WORK AGAIN

Everybody knows how to jumpstart a car, right? Doing it wrong can potentially fry sensitive electronics. Shut off the donor car, hook 'em up—make the last connection to the dead car's engine block, not the battery post—and let the two batteries commune for a minute. Start the donor car engine and let it idle for 5 minutes. Then start the dead car.

A better way is to use a battery charger to recharge the dead battery at a normal rate.



tip no. 13

IT'S ALIVE!

A TRULY DEAD BATTERY WILL HAVE A VERY HIGH INTERNAL RESISTANCE. ***IF YOU JUMPSTART THE CAR, IT SHOULD RUN—BUT THE BATTERY WON'T TAKE MUCH CHARGE, LEAVING YOU STRANDED WHEN YOU TRY TO START THE CAR AGAIN.*** IT MAY TAKE AS LONG AS 24 HOURS WITH A BATTERY CHARGER TO PUT ENOUGH CHARGE INTO A DEAD BATTERY TO LOWER THE INTERNAL RESISTANCE ADEQUATELY TO ACCEPT ANY CHARGING CURRENT. SO PATIENCE IS IN ORDER. ON THE OTHER HAND, A BATTERY THAT'S BEEN SO PROFOUNDLY DRAINED IS DAMAGED AND WILL NEVER HAVE THE SAME STORAGE ABILITY IT ONCE DID.

PHOTOGRAPH BY DENNIS KLEIMAN





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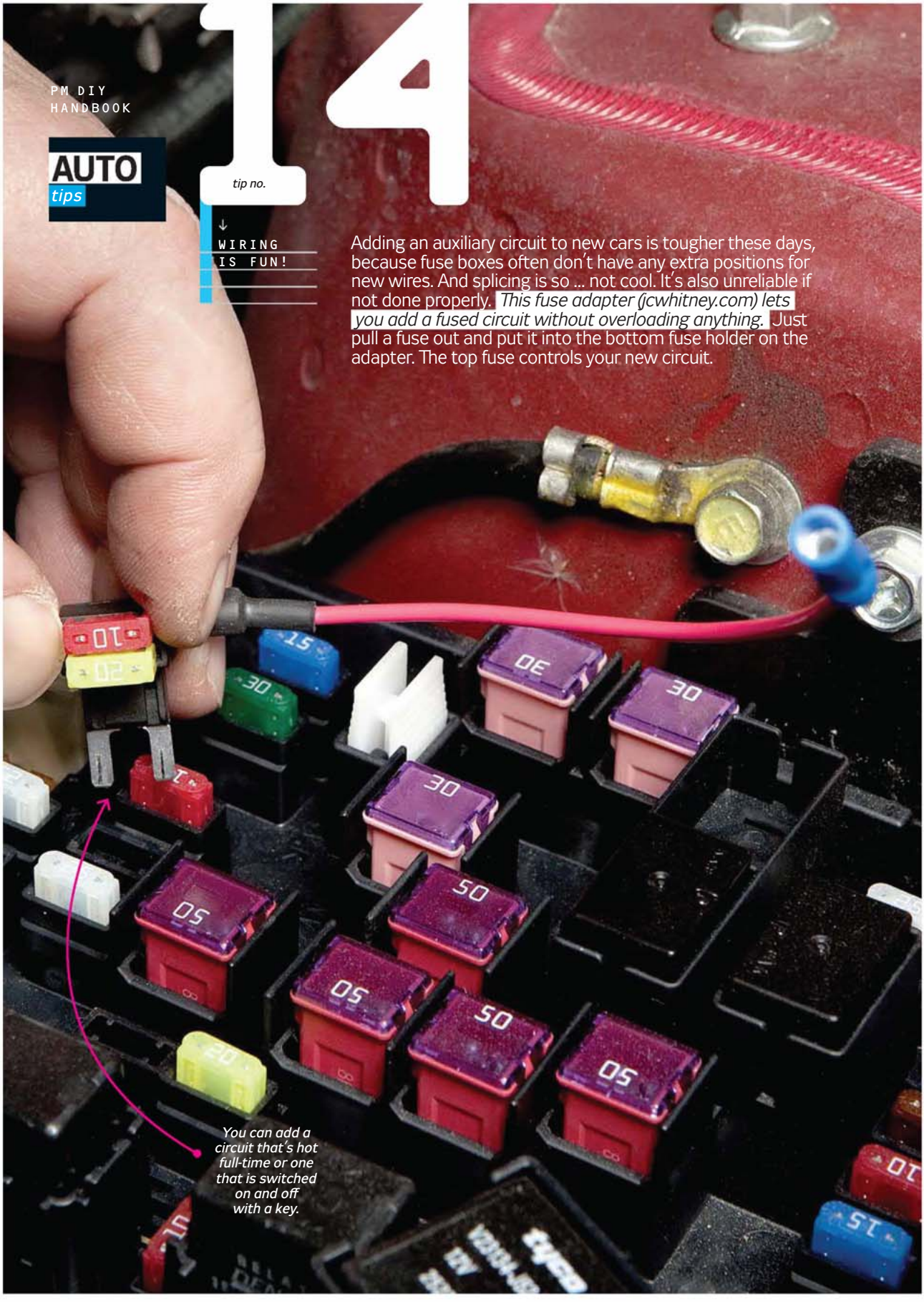
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AUTO tips

tip no. 14

↓ WIRING IS FUN!

Adding an auxiliary circuit to new cars is tougher these days, because fuse boxes often don't have any extra positions for new wires. And splicing is so ... not cool. It's also unreliable if not done properly. *This fuse adapter (jcwhitney.com) lets you add a fused circuit without overloading anything.* Just pull a fuse out and put it into the bottom fuse holder on the adapter. The top fuse controls your new circuit.



You can add a circuit that's hot full-time or one that is switched on and off with a key.

PHOTOGRAPH BY CHAD HUNT


✓Yes


✓Yes


✓Yes


xNo


✓Yes


✓Yes


✓Yes

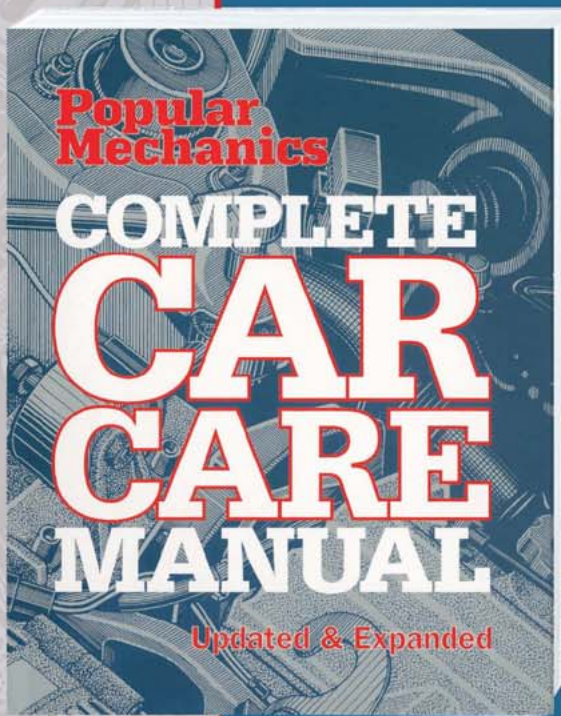

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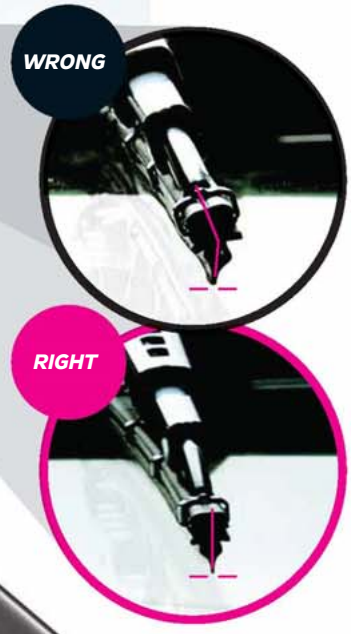
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AUTO
tips

CHATTER-
BOX

tip no.
15

Chattering wipers can make you dread rainy days. *Check the wiper blade to make sure it's perpendicular to the window glass at the center of its arc.* Use a pair of wrenches to carefully twist the arm so the blade has the same angle to the glass as it sweeps in either direction. Just don't scratch the glass!



PHOTOGRAPHS BY CHAD HUNT

WHICH WOULD YOU RATHER BE IN CHARGE OF: A SIX-BY-SIX FOOT CUBICLE OR A MULTIBILLION DOLLAR WARSHIP?



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